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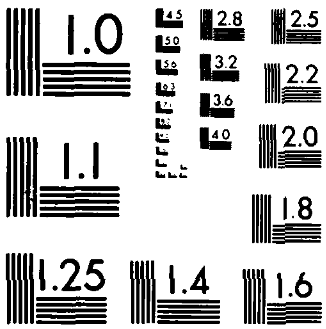

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Airpower Research Institute

Research Report No. AU-ARI-82-4

MEETING AIR TRAINING COMMAND'S FUTURE AIRSPACE NEEDS

By

Peter L. Fekke
Lieutenant Colonel, USAF

... been approved ... and sale; its distribution is unlimited.

Air University (ATC)
Air War College
Maxwell Air Force Base, Alabama

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Peter L. Fekke
Lieutenant Colonel, USAF

Airpower Research Institute
Maxwell Air Force Base, Alabama

August 1982

DISCLAIMER-ABSTAINER

BIOGRAPHICAL SKETCH

Upon entering the Air Force in 1965, Lieutenant Colonel Peter L. Fekke completed undergraduate pilot training at Moody AFB, Georgia. His operational experience began in the KC-135 tanker aircraft and continued in the HH-53 rescue helicopter based in Thailand. He returned to fly the KC-135 before being assigned to the FB-111 strategic bomber mission. After earning a masters degree in operations research at the Air Force Institute of Technology, he was assigned to Air Training Command headquarters planning staff in the studies and analysis directorate.

ACKNOWLEDGMENTS

In researching and writing this research report, there are some people to whom I am grateful. Colonel Kenneth Alnwick, the Director of the Airpower Research Institute (ARI), and Lieutenant Colonel Donald Baucom, the Deputy Director of ARI, advised and guided my efforts as I prepared this manuscript.

The editorial staff at ARI--John Schenk, Dorothy McCluskie, Jo Ann Perdue, Connie Smith, Marcia Williams, and Edna Davis--helped me tremendously in the many steps in getting my manuscript into a final product. Hugh Richardson and Tom Lobenstein of Academic Publications edited the final draft.

I am indebted to each of these people and many more. My sincere thanks to each of you.

EXECUTIVE OUTLINE

Meeting ATC's Future Airspace Needs

Findings

1. Current NAS developed piecemeal to cope with rapidly expanding environment.

2. FAA now planning more efficient en route system which will be highly automated.

3. FAA terminal areas will be consolidated into major urban traffic hub areas.

4. Hence, current military problems in obtaining unique support will probably continue.

5. Civil demand and competition for airspace and controller support will increase in the future.

   a. Private flying could double in 9 years.

   b. Business flying will increase in quantity and competition for IFR support at higher altitudes.

   c. Commercial structure will change (increased demand) as more commuter and air taxi operations use more IFR service at greater altitudes.

6. Military demand for airspace and controller support will also increase slightly (not planned for by FAA).

   a. More low-level, night, tactical, joint training requirements in the future.

   b. ATC will follow these changes with similar changes to its programs and airspace requirements.

c. ATC will operate at near maximum capacity for some time at five bases (more may be required) if the FAA does not support specific command airspace requirements.

7. Local military controllers can most efficiently provide the type of terminal support required by ATC.

INTRODUCTION

This monograph documents a long-range planning effort which examines future airspace availability and the needs of Air Training Command (ATC). With respect to airspace needed, ATC is planning to change the undergraduate pilot training (UPT) program. The current generalized UPT program uses the same resources to train all student pilots regardless of their following operational assignment. Students fly both the T-37 in primary and T-38 in basic flying training en route to earning a pilot's rating. The system is destined to change to a specialized undergraduate pilot training (SUPT) program.[1] In this program, after a common primary training phase in the T-37 or its replacement (called NGT, for next generation trainer), students may fly either a T-38, if they are to operate fighter-type aircraft, or a new multiengine trainer aircraft, if they are to fly multiengine type aircraft operationally. So, given the new program, it becomes prudent to at least reevaluate ATC's airspace requirements for the future. Once the needs are established and are compared to the airspace that will be available, specific actions can be taken (both near and long term) to assure that ATC will be able to work effectively in the future flying environment.

The airspace resource is unique in that its volume is a constant. The total amount of it cannot grow, unlike the other resources which can be added to or reduced. This examination is limited to a specific ground area (the continental United States) and extends upward to a specific distance (for purposes of this study, 50,000 feet above sea level). Although the volume does not change, many other factors affecting the amount of airspace available to and required by ATC will change.

Competition from the civil sector for this fixed resource has been increasing. Commercial aviation operations (including air carrier, air taxi, and commuter operations) have grown. Also, the number of private flyers is growing.[2] As these civil demands have increased, ATC's proportion of the available airspace has tended to get smaller. Although actual ATC requirements have increased, the command's total airspace requirement is proportionately smaller than that of other users. However, one must be careful not to think of a portion of airspace as being necessarily reserved for ATC.

The national airspace system (NAS) design essentially allows everyone to use most airspace at different periods of time. This system can be compared to a highway which has safely spaced traffic flowing from one point to another. Everyone uses the same airspace which is divided on the basis of time increments. This puts space between aircraft in flight. There are airspace parcels restricted to special use, primarily for the military. Some are essentially restricted all the time and some only at specific times. ATC uses some of the en route portion, but mostly it uses unique unrestricted blocks of the NAS. These fixed specific volumes are used primarily during daylight hours when weather conditions permit flying by visual reference to the ground rather than by reference to instruments only. When the weather is bad, the command's operations are curtailed considerably.

Even though the NAS volume is fixed, the specific airspace portion each user wants to use may change. General aviation pilots and aircraft are becoming more sophisticated. This tends to increase the altitudes they use

and add to the amount of air traffic control services they require. The deregulation of airlines has taken the larger companies out of the unprofitable shorter routes (mandatory during regulation). The result has been increased air taxi traffic. The smaller air taxi aircraft operate on different schedules and at different altitudes than the trunk airlines. Thus, the total commercial requirement for airspace is changing.

Within the Department of Defense (DOD), changes in the aircraft operated alter defense airspace needs. As new aircraft are added to the inventory and old ones are deleted, base structures and locations of needed airspace are altered. Also, evolving tactics and lessons learned from recent conflicts have shown a need to get more realistic training. This has caused changes in airspace requirements, both in terms of larger restricted blocks for maneuvering and joint training exercises and also in the increased use of high-speed, low-level, and all-weather training. This demonstrates that the airspace available to and required by ATC will change.

Thus, the question here is how best to structure ATC's airspace requirements in the period between 1985 to 1990. The question must encompass the environment of the multiengine trainer and T-37 replacement aircraft and the action to be taken between now and 1985 to achieve the proper airspace structure.

To determine the best structure, it will be useful first to review the history of the NAS. Also, the projected system requirements beyond 1990 are important since the new systems implemented in the mid-1980s will probably be used at least 20 years. The first chapter reviews the history of the NAS in terms of an overview of the history of aviation in this country,

Federal Aviation Administration (FAA) development, and ATC's interface within that development.

In Chapter II, the planned NAS improvements are examined to help establish what the environment will be like during the latter part of the 1980s. In addition, forecasts of civil aviation growth are examined to help determine the amount of competition for airspace and what portions civil users will probably want to use.

The next chapter evaluates the future requirements of DOD users (besides ATC) within the NAS. This, combined with the results of Chapter II, will show what parts of the airspace pie will be most available and what parts will be harder to get. This will complete the determination of airspace availability. In the course of compiling these future Air Force airspace requirements, planned force structure will be reviewed. Future force structure requirements, combined with planned personnel retention rates, will then determine what ATC training and force requirements will be.

Chapter IV establishes the specific airspace requirements of ATC generated by the new SUPT system and aircraft to be used. The unique airspace requirements, combined with the system basing concept and total training requirements, are used to establish the future airspace needs of ATC. Then the impacts of future changes are used to indicate potential problems. The chapter suggests future alternatives and discusses the effects of these alternatives.

Chapter V summarizes the findings, recommends an airspace structure for the mid- to late-1980s and beyond, and suggests near-term actions. This study can be used as a source document in developing the

final SUPT training concept. In addition, it should facilitate better cooperation with the FAA by documenting ATC's airspace requirements early enough for the FAA to respond, as is their charter, and to help the command's staff to better understand the NAS as seen by the FAA. The need for better cooperation between the military and FAA has been noted by the congressional staff, and this document is part of an effort to enhance the cooperative atmosphere desired by both organizations.[3]

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CHAPTER I

HISTORY OF NAS SYSTEM DEVELOPMENT

This chapter reviews briefly the history of aviation in this country through the development of the NAS structure and the FAA organization. The review of the FAA's organizational development helps one to understand the highly political atmosphere of matters involving the NAS. Reviewing the comparative growth of the elements of aviation will help in the understanding of how the system got to be the way it is today. This review begins by tracing federal legislation and the name changes of the FAA from 1926 to the present. It then examines actual airway structure development and how the actual air traffic control system has evolved. Finally, the civil and DOD air traffic growth rates are compared to demonstrate further how the system developed.

Early Aviation Development

The use of airspace by aircraft began with the Wright brothers at Kitty Hawk, North Carolina, on 17 December 1903, but aeronautical development within this country was very slow in the years that followed. There were only 26 licensed pilots in the United States in 1911 when Lieutenant Benjamin Foulois was the Army's only pilot flying its only airplane.[1]

Even though there had been slow progress in the use of aircraft in this country prior to World War I, other countries were exploring the aircraft's military potential as early as 1911. The Mexican Government had reconnoitered rebel positions by air, and Italy had used aircraft against Turkey in both surveillance and air-to-ground roles by this time.

Air-to-air fighting began in the first days of World War I.[2] Edward H. Sims substantiates the developing value of military airpower in his book Fighter Tactics and Strategy.

> At the outbreak of the First World War in 1914, of course, few had any idea that pilots or air units would exert much influence on land battles. But perceptive pilots, and other keen observers of events, soon began to realize the tremendous potential of air power. By the third year of the war, 1917, the great von Richthofen was, in fact, called back to the front while on leave because the British Army had wrested air superiority from the Germans over the Messines front, practically driving German Air Service scouts from the skies. (British infantry was advancing unhindered by accurate artillery barrages, only possible with up-to-date information obtained by aerial observation.) At Third Ypres and at Cambrai in 1917, strafing had become a significant factor in the fighting. In the last German drive in the West (the first Battle of the Somme), which broke on 21 March 1918, heroic bombing and strafing efforts by the greater number of Allied aircraft helped prevent the British retreat from turning into a rout. Air power was by that time, therefore, already a major factor in the war on the ground.[3]

World War I provided the impetus for the United States to build 11,000 airplanes; and by the end of the war, there were nearly 9,500 men in the Air Service.[4] During the War, the War Department and the Post Office Department cooperated in establishing and operating mail routes using both airplanes and trains. True airmail service actually began on 1 July 1924. Lights were installed between Chicago and Cheyenne, Wyoming, making night flights and an uninterrupted route between these cities possible. The Airmail Act of 1925 led to contract mail service with commercial carriers and created the foundation for the commercial airline system in the United States today.[5]

After World War I, approximately 9,000 pilots were released from the Air Service. With mostly surplus aircraft, these pilots represented the beginning of private aviation in this country. For a few dollars, these "barnstormers" would give aerial sightseeing flights.[6] They put on

flying exhibitions anywhere crowds gathered and stimulated public interest in airplanes and flying.

Hence, the military, commercial, and private use of aircraft and airspace had all begun. Congress had realized that aeronautical progress depended on federal help and guidance and had created the National Advisory Committee of Aeronautics (NACA) in 1915.[7] The committee, as well as the aviation industry, worked for federal regulation, but Congress was reluctant to act mainly because of aviation's status in the national defense structure. Ultimately, the controversy created by General Billy Mitchell caused President Coolidge to appoint Dwight W. Morrow chairman of a board to study the subject of national aviation.[8] ". . . the Morrow Board recommended the separation of military and civil aviation, the creation of a civilian bureau, and the appointment of three additional Assistant Secretaries of War, Navy, and Commerce. . . ."[9]

The Air Commerce Act of 1926 came from the Morrow Board's recommendations, but <u>it applied only to civil aviation</u>.

> The Act instructed the Secretary of Commerce . . . to foster air commerce; designate and establish federal airways; establish, operate, and maintain aids for air navigation (except airports); arrange for research and development to improve such aids; license pilots and other airmen; issue airworthiness certificates for aircraft and major aircraft components; and investigate accidents.[10]

The Act was promotional rather than regulatory. It divided responsibility in safety rulemaking and in airspace allocation. The President was authorized to reserve airspace for national defense or other governmental purposes. Also, the Secretary of War was authorized to designate military airways.[11]

FIGURE 1. Sequence of Names

NAME	PERIOD	REASON
Aeronautics Branch, Department of Commerce	1926-1934	Promote aeronautics by government
Bureau of Air Commerce, Department of Commerce	1934-1938	Consolidate and reorganize functions
Civil Aeronautics Authority, Independent agency	1938-1940	Create independent agency
Civil Aviation Administration, Department of Commerce	1940-1958	Clarify organization; move to Department of Commerce
Federal Aviation Agency, Independent agency	1958-1967	Create independent agency
Federal Aviation Administration, Department of Transportation	1967-	Reorganize; included in new Department of Transportation

FAA Organizational History

The history of the Federal Aviation Administration (FAA) can be traced back to the Aeronautics Branch, which was created in 1926 under the Department of Commerce.

Aeronautics Branch

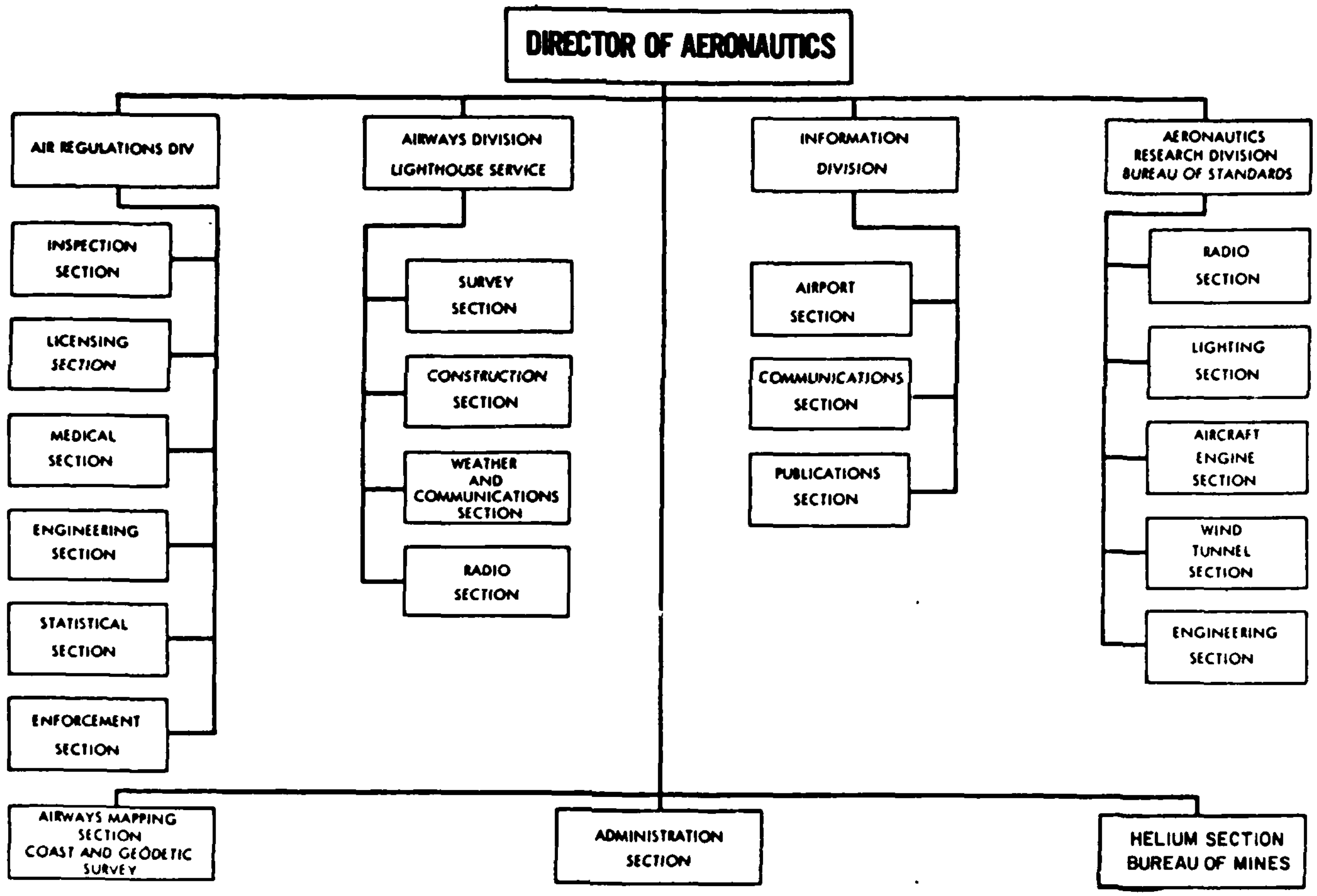
The Aeronautics Branch consisted of five principal organizations: Air Regulations Division, Air Information Division, Airways Division, Aeronautical Research Division, and Air Mapping Section. The first two were structurally part of the Aeronautics Branch; the other three were structurally within other bureau-level components of the Department of Commerce and received directions from the branch about what work was to be done.[12]

The Aeronautics Branch lasted from 1926 to 1934 and proceeded with the work directed by the Air Commerce Act of 1926. Regulations were issued requiring all aircraft to be registered and marked. Pilots and mechanics involved in interstate commerce had to be licensed. Air traffic rules and airway strip maps were issued. The evolving Aeronautics Branch underwent numerous organizational changes.[13]

Bureau of Air Commerce

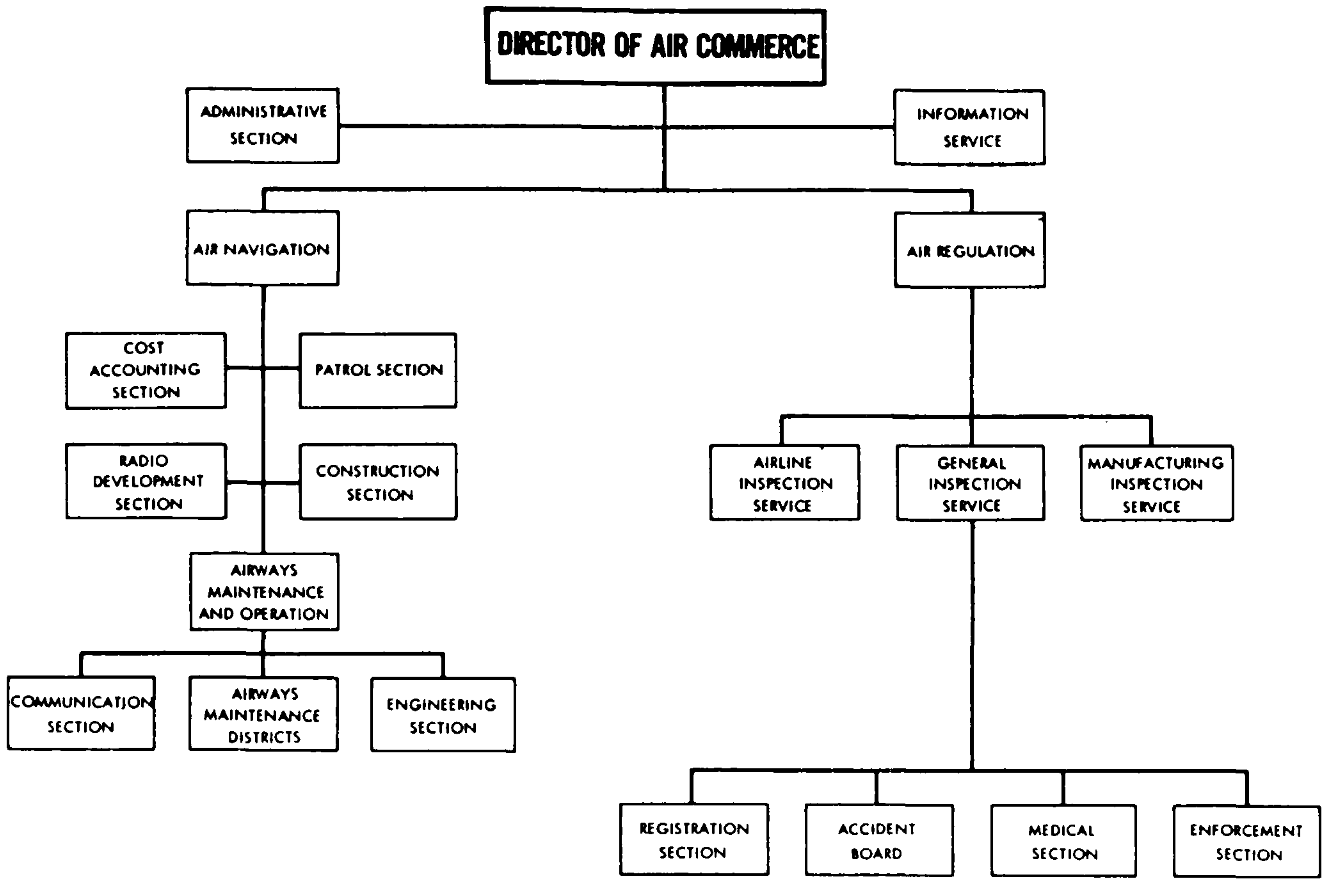
After further reorganization in 1934, the Aeronautics Branch became the Bureau of Air Commerce and continued to exercise the responsibilities given by the Air Commerce Act of 1926. A Development Section was created to help produce new types of aircraft, engines, and accessories. New safety requirements for airlines were issued. Methods and requirements for controlling airport and airway traffic were drafted.[14]

FIGURE 2. Aeronautics Branch (1928)



Source: FAA Historical Fact Book

FIGURE 3. Brueau of Air Commerce (1934)



Source: FAA Historical Fact Book

Since passage of the Airmail Act of 1925, the Post Office Department had been using its ability to issue airmail contracts to help establish a stable and efficient national air transport system. Unfortunately, contracts were issued to carriers most likely to further the industry instead of by competitive bidding as required by law.[15] Although this was effective in expanding the air transport and airway system, congressional investigation of the contracting process forced all existing mail contracts to be cancelled on 19 February 1934. Congress reopened competitive bidding for airmail contracts with the Airmail Act of 1934.[16] This Act transferred the power to adjust airmail carriage rates to the Interstate Commerce Commission (ICC) while the Postmaster General still granted route contracts. In addition, a commission was authorized to study all phases of aviation and to recommend broad policy concerning the relationship of the United States to it.[17]

In February when all airmail contracts were cancelled, President Roosevelt directed the Army Air Corps to begin carrying the mail. The Corps carried the mail until 1 June 1934 but not without several accidents. This prompted the Secretary of War to appoint the Baker Committee to report on the Army's capabilities in peace and in war. The committee found that practically all deficiencies in the Air Corps' armament, equipment, and munitions were traceable to a lack of funds. [What's new?] "It also recommended that Army pilots be trained to use the national airways."[18]

The Federal Aviation Commission, authorized by the Airmail Act of 1934, began meeting in July 1934 and submitted its report to the President on 22 January 1935. Several recommendations for change were made. The Commission suggested air transportation should be treated in much the

same way as land transportation, with competition for routes to be a guiding principle. A temporary Air Commerce Commission was suggested to carry out economic and safety regulations for the industry, and some aid for airport development was suggested. The rest of the Bureau of Air Commerce's function was to remain intact. Initially, President Roosevelt disagreed with the idea of a temporary Air Commerce Commission in favor of the ICC regulation of air commerce.[19] He changed his mind in 1938. After 4 years and some 30 bills on the subject had been introduced in Congress, the Civil Aeronautics Act of 1938 was passed.[20] It replaced provisions of the Airmail Act of 1934 and most of those of the Air Commerce Act of 1926. "However, the divided responsibility between military and civil air operations in safety rulemaking and allocation of navigational airspace . . . was not changed."[21] A new regulatory agency in the field of transportation was created.

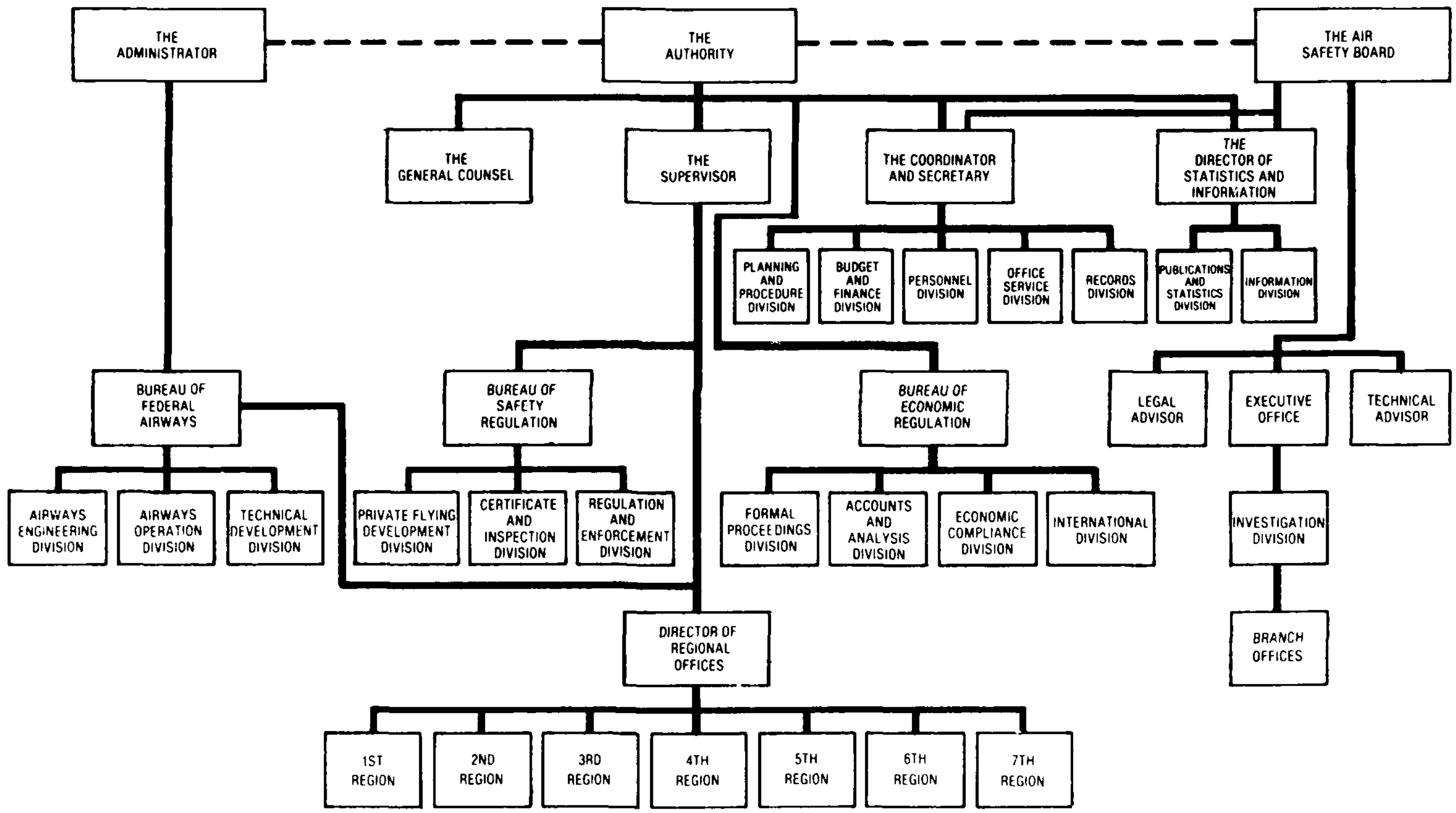
Civil Aeronautics Authority

The Civil Aeronautics Act of 1938 established the Civil Aeronautics Authority (CAA) which inherited the personnel and property of both the Bureau of Air Commerce and the ICC's Bureau of Airmail. The structure and functions of the new CAA are summarized in the FAA Historical Fact Book:

> A five-man board responsible for economic regulation of aviation, for safety rulemaking, and for various other functions.
>
> An administrator, responsible for the agency's operational functions--certificating airmen and aircraft, enforcing safety rules, laying out airways, and providing and maintaining airway navigational aids, including airports. . . .
>
> An independent three-man Air Safety Board, responsible for investigating aircraft accidents and recommending safety improvements.[22]

Hence, economic and safety regulations for aeronautics were now made by a five-member board. An administrator ran the Civil Aeronautics

FIGURE 4. CIVIL AERONAUTICS AUTHORITY (1939)



SOURCE: FAA HISTORICAL FACT BOOK

Authority and enforced the regulations, and the three-man Air Safety Board investigated accidents.

The Act of 1938 also directed members of the Agency to survey the existing airport system to determine if the Federal Government should play a part in developing a national system of airports. They reported that the Federal Government should help develop and maintain an adequate system of airports.[23]

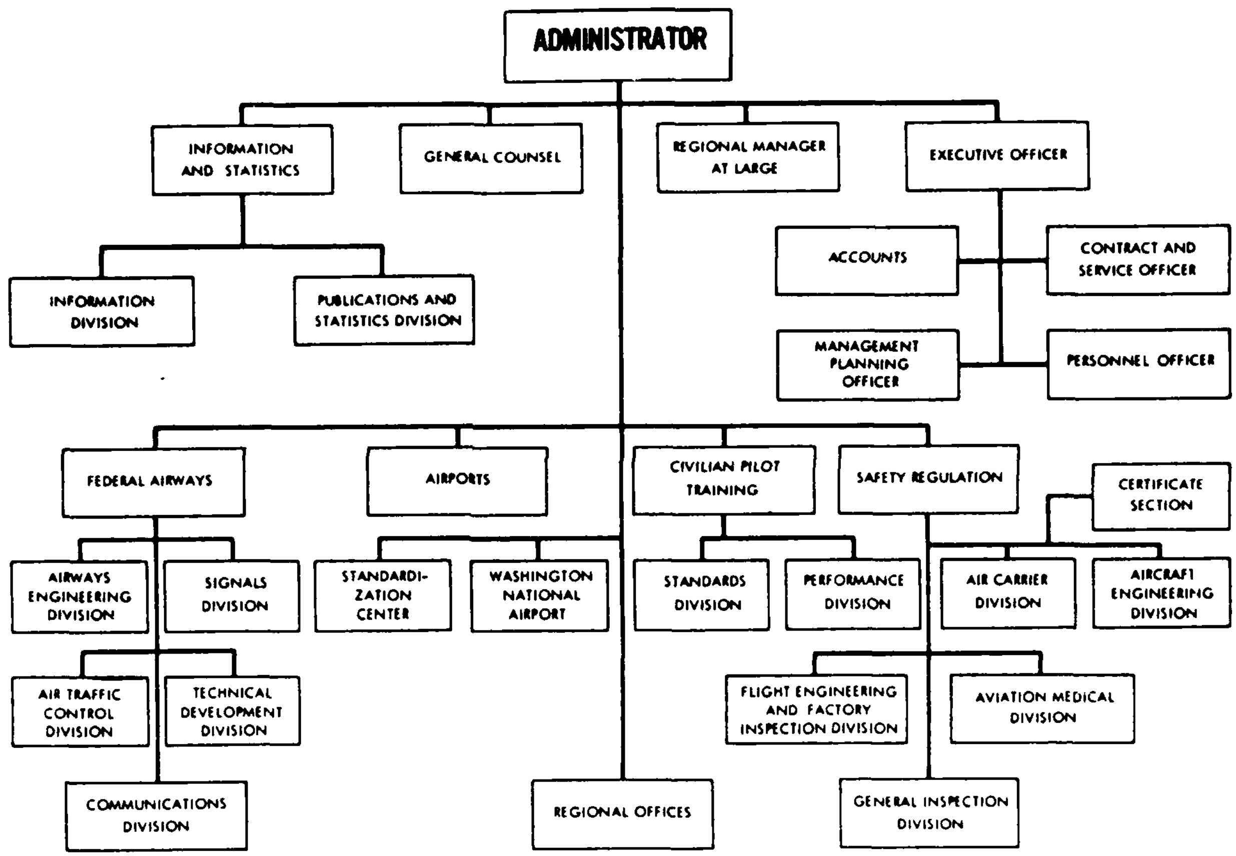
The purpose of the Civil Aeronautics Act was to foster a commercial air transport system to meet the needs of commerce, the postal service, and national defense.[24] However, the organizational structure that existed did not seem to work well. The result was: "Organizational difficulties, duplication of activity, and dissension within the ranks of the Safety Board. . . ."[25]

In an effort to make the Federal Government more responsive to the general interest and vital needs of the country and to improve the President's ability to control the government, a presidential committee studied administrative management procedures starting in 1937. It determined that broad functional groupings of the many related governmental functions of the executive establishment were required.[26] The result of the committee's finding was the Reorganization Act of 1939.[27]

Civil Aeronautics Administration

In June 1940, President Roosevelt used the powers granted him by the Reorganization Act to reorganize the Civil Aeronautics Authority. The Civil Aeronautics Authority was split into entirely separate rulemaking and operational bodies. The five-member board of the Civil Aeronautics Authority was renamed the Civil Aeronautics Board (CAB), was transferred to

FIGURE 5. Civil Aeronautics Administration (1942)



Source: FAA Historical Fact Book

the Department of Commerce for administrative support, and was assigned the accident investigating function of the Air Safety Board, which was abolished. The CAB retained the power to regulate civil aviation. The operational functions of the Civil Aeronautics Authority were transferred to a Civil Aeronautics Administration (hence the initials CAA were still used). The administrator now became the Administrator, Civil Aeronautics Administration, who operated under the supervision of the Secretary of Commerce.[28] The Civil Aeronautics Authority continued to exist on paper and embraced both the CAB and Civil Aeronautics Administration but performed no functions.

This reorganization did not solve all of the CAA's difficulties, and a number of small changes took place en route to the passage of the Federal Aviation Act of 1958.[29] In fact:

> Chairman Oren Harris of the House Committee on Interstate and Foreign Commerce pointed to the 1940 reorganization plans as the beginning of many problems. He explained that many persons felt that under the Act of 1938, the Civil Aeronautics Administration had been intended to function independent of the executive branch.[30]

Harris believed that the nation would have been better off if the CAA had remained independent.

The CAA took part in the development of airport facilities and took over operation of many existing airport control towers.[31] World War II was to provide impetus for profound changes in civil and military aviation. Significant advances were made in aircraft, engines, communications, and radar which were to impact air traffic control systems and systems requirements in the future. Between May 1940 and September 1943, 123,000 airplanes were built and the first US jet aircraft were flying.[32]

In April 1941, an Interdepartmental Air Traffic Control Board was sponsored by the War Department. It included representatives of the Army

Navy, CAA, and CAB who made decisions about the location of military air installations. They also helped establish many procedures for the control and regulation of air traffic and resolved civil-military airspace use problems. This Board was the forerunner of the Air Coordinating Committee which was established in March of 1945 and formally chartered 19 September 1946.[33]

In May 1946, Congress passed the Federal Aid to Airports Act, which provided federal grants-in-aid to airports. This act was amended a number of times because of conflicting views between the executive branch and legislative branch about how it was to be administered. The Republican administration had not spent all the funds that Congress had appropriated to be used. Federal support of civil airport development was seen as beneficial to support the needs of interstate commerce and "national defense." The disagreement between Congress and the executive branch would provide impetus for change.[34]

In the meantime, President Truman set up a temporary Air Policy Commission to look into national aviation policies and problems. Their report suggested major changes in the organization of the CAA. Under their recommendation, the CAA would have become the Office of Civil Aviation reporting directly to the Secretary of Commerce. It would have the existing CAA functions and the responsibility for safety regulations then held by the CAB. Attached to the new Office for Administration was to be an independent CAB to make civil rate and route decisions and an independent Air Safety Board to investigate accidents.[35] The report also recommended that primary responsibility for future air navigation system development be assigned to either military or civil air authorities.[36] However, none of these changes were made.

In November 1948, the creation of an Air Navigation Development Board (ANDB) was announced. It consisted of representatives from the Army, Navy, Air Force, and CAA and was tasked to help develop a common national system of air navigation and traffic control to meet the needs of both civil and nontactical military aviation,[37] which was seen to be within the scope of these organizations' normal functions.[38]

As a result of the suggestions by the Hoover Commission on government organization, the CAA was placed under control of the Under Secretary for Transportation, Department of Commerce, in 1950.[39] This was an important step toward a unified transportation department.[40] At this point, other government agencies--in particular the DOD--also had responsibilities for the development of aviation facilities.

In May 1955, President Dwight D. Eisenhower asked William B. Harding to study the nature and seriousness of the identified air traffic control problem. The Harding Committee determined:

> . . . first, there was a need for a study; second, information was needed as to how to make efficient use of national airspace, how to integrate military and civilian expenditures . . . and what type of government organization would be required; finally, it was recommended that an individual of national reputation and broad understanding of military and civil aviation be appointed to head the study. . . .[41]

The President appointed Edward P. Curtis to lead this study beginning in February 1956.

An interim report was issued by Mr. Curtis in April 1957 with the final report following in May. The study found that the organizations that were supposed to select systems and methods for controlling air traffic were not effective in expediting necessary changes.[42] Midair disasters

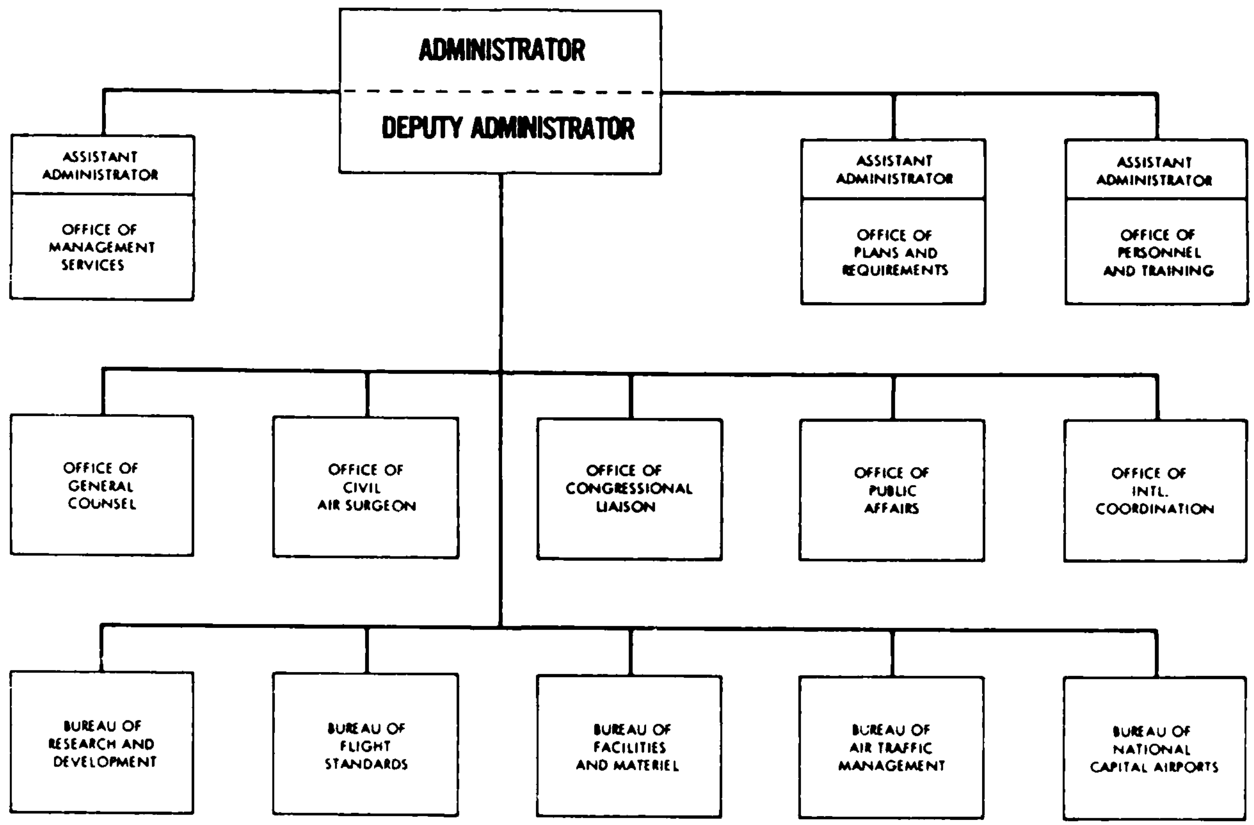
in late 1956 and early 1957--particularly the midair crash of two airliners over the Grand Canyon on 30 June 1956 which claimed 125 lives--had focused public concern for the need of immediate improvements to flying safety. As an interim measure, a temporary Airways Modernization Board was introduced to expedite development of a modern, integrated air traffic control system.[43]

The final Curtis report outlined a two-step approach to developing a system that would support civil and military aviation needs of the future. The first step was the establishment of the Airways Modernization Board by the Airways Modernization Act of 1957. This new board took over the functions of the ANDB. The Airways Modernization Board had three members: the Secretaries of Defense and Commerce (or their representatives), and a chairman who was appointed by the President (and approved by the Senate). Significantly, except for actions pertaining to transfer of activities from other departments, only a majority vote was required by this board. This accelerated the decision process. The second step, as provided by the act, was for this board to be terminated on the last day of June 1960 and legislation establishing an independent Federal Aviation Agency to be submitted to Congress before January 1959.

Federal Aviation Agency

The above action resulted in the prompt passage of the Federal Aviation Act of 1958, which established the independent Federal Aviation Agency and freed the CAB from its administrative ties with the Department of Commerce. The act assigned to the Federal Aviation Agency and CAB all those functions established originally by the Air Commerce Act of

FIGURE 6. Federal Aviation Agency (1959)



Source: FAA Historical Fact Book

1926, the Civil Aeronautics Act of 1938, the Airways Modernization Act of 1957, and those portions of the various presidential reorganization plans dealing with civil aviation.

The FAA took over the CAA organization and functions, the functions of the Air Coordinating Committee, as well as the responsibilities and personnel of the Airways Modernization Board. Additionally, the Federal Aviation Agency took most of the CAB's authority for safety regulation and enforcement.

The administrator was to regulate air commerce so as to promote its development and safety, and to fulfill the requirements of national defense. He was to promote, encourage, and develop civil aeronautics. He was to regulate and to control the use of airspace in both civil and military operations in the interest of safety and efficiency. All research and development, installation, and operation of navigation facilities were his responsibilities. And finally, he was to develop and to operate a common air traffic control and navigation system for both civil and military aircraft.[44]

The CAB retained responsibility for economic regulation and accident investigation, although investigation of accidents involving only military aircraft was left to the military services. But, in the event of any accident which involved substantial question of public safety, the board could convene a Special Board of Inquiry.[45]

The Federal Aviation Agency was an independent governmental agency. This arrangement lasted from 1958 through 1967. The administrators and their organizations advanced safety with emphasis on integrating jet aircraft into the system and producing a system of air traffic control for

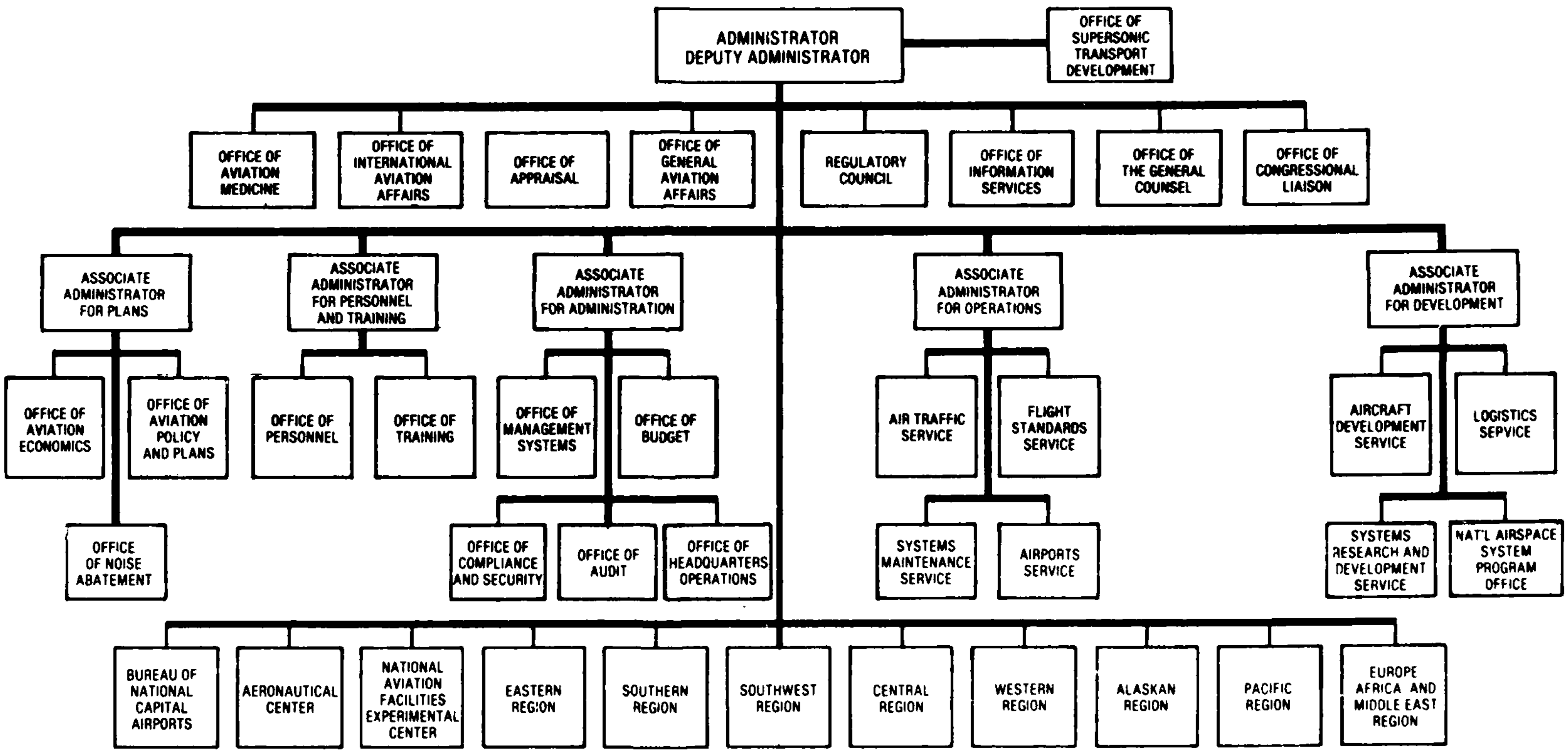
all users. They began to create the mandated single system of air traffic control with the military. The vehicle was Project Friendship, which mostly was the transfer of military equipment and facilities to the Federal Aviation Agency.[46] Computers were integrated into the air traffic control system. Both aircraft and air traffic control systems capabilities advanced rapidly. The goal of creating a common aviation system for commercial, private, and military use was well on the way to completion.

At this point, Congress decided that an integrated and balanced transportation system would best support the nation's transportation needs. The Department of Transportation Act of 1966 brought 31 different federal elements together in one cabinet department. It was responsible for all federal transportation programs. Consideration was to be given to needs of the public, users, carriers, industry, labor, and the national defense.[47]

Federal Aviation Administration

As a result of the Department of Transportation Act of 1966, the Federal Aviation Agency was transferred to the Department of Transportation (DOT) in April 1967 as the Federal Aviation Administration. At this time, a five-member National Transportation Safety Board was created to investigate and to determine the cause of accidents and to review actions taken concerning certificates and licenses. To do this fairly, the board was made independent of the DOT. The ultimate responsibility for aviation safety, however, belonged to the Federal Aviation Administrator. The Airline Deregulation Act of 1978 amended the Federal Aviation Act of 1958 to deregulate the industry. The full impact of that deregulation on the system has yet to be felt.

FIGURE 7. FEDERAL AVIATION ADMINISTRATION (1968)



SOURCE: FAA HISTORICAL FACT BOOK

This completes the review of the organizational development and pertinent legislation leading to the current FAA organization, which is now a single air traffic control system. Although the requirement for such a system is obvious, there has been some difficulty in balancing the system to satisfy all users. The FAA's decisions are, of course, influenced by various user groups. In line with congressional intent, its decisions involving the NAS structure, control development, and airspace allocation must fully consider military needs. However, this goal of supporting both the national interest and the needs of system users has caused some conflict. Worthy of note is the fact that recent leadership within the FAA has less military background than the early leadership.

Following is a quick review of the development of airway structure and control.

Airway and Air Traffic Control Development

The total NAS is very complex and includes elements for air traffic control, navigation, and flight information services.[48] The emphasis of this review is concerned more with the physical space that has been used in the aviation system structure. That space can be divided into departure and terminal areas around airports; en route sections like highways; special-use areas such as air refueling areas, low-level routes, and military operations areas.

Geography

To help understand the development of US airway route structures, some general observations about North American continental geography will show how it tends to affect the country's air routes. Generally, transcontinental departure points are on the east or west coasts or at New Orleans

Houston, or San Antonio in the South. [illegible] international travel. The main [illegible] within the CONUS are the north-to-south oriented [illegible] West and East, and also the Mississippi River. [illegible] opment of very long east-to-west lines of ground [illegible] exception being the waterway system from the East [illegible] states. These features have stimulated travel, population growth, [illegible] industrial expansion along the coastal areas and [illegible] Hence, air traffic density tends to be highest up and [illegible] cross country through Chicago. These general patterns, however, are augmented by diverse feeder systems throughout the [illegible]

Routes

The airmail service provided the first airways in this country. The first flights were on a route between Washington and New York in May 1918.[50] By 1920, a route was developed from New York through Chicago to San Francisco--about 2,600 miles. In July 1927, the route was transferred from the Post Office Department to the Department of Commerce.[51] [illegible] were becoming big business. Emphasis was shifting to transcontinental routes and nationwide systems.

These first airways were nothing more than beacon lights at [illegible] intervals. By the 1930s, radio range, broadcast stations, and weather teletype service had been added.[52] An airway modernization program, [illegible] in 1937 by the CAA, was completed in 1939. The federal [illegible] consisted of 231 low-frequency navigation, radio range [illegible] establishing 25,500 miles of airways.

During World War II, aircraft and aeronautic systems advanced rapidly. Beacon lights had given way to radio navigation aids. In [illegible] 1950, the CAA put into operation the first VHF omnirange (VOR) airways which used the more modern VOR ground-navigation radios. The 4,380 miles of controlled airways delineated by 271 VOR radios linked major terminal areas. By 1952, there were 45,000 miles of these airways to go with the 70,000 miles of low-frequency airways. Tables 1 and 2 illustrate the growth of the airways system in this country from 1953 to 1979.

FIGURE 8. First Transcontinental Airmail Service Airway

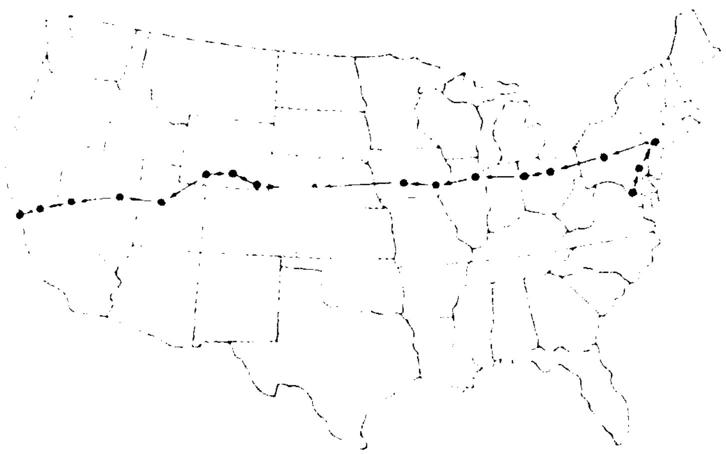


TABLE 1. US Air Route Airway Mileage [illegible]

(Contiguous [illegible])

Dec 31	Low frequency	Very high frequency VOR [illegible]			
		Low altitude Direct	Low altitude Alternate	Intermediate altitude	[illegible]
1953....	72,097	54,490	21,379	-	
1954....	69,359	64,995	22,783	-	-
1955....	67,770	81,209	27,418	-	-
1956....	67,783	90,268	29,773	-	-
1957....	64,817	104,484	30,563	-	-
1958....	57,705	124,870	34,723	-	n.a.
1959....	47,302	129,632	35,204	-	n.a.
1960....	36,879	3/ 142,045	38,486	-	75,640
1961....	2/ 14,543	120,904	33,448	-	77,950
1962....	10,559	126,235	34,081	103,281	78,905
1963....	9,038	128,153	34,524	103,063	82,031
1964....	8,242	131,747	29,713	4/	88,810
1965....	6,630	135,226	30,017	4/	91,224
1966....	394	130,837	29,714	4/	93,863
1967....	388	133,177	30,151	4/	95,944
1968....	322	137,112	31,359	4/	103,708
1969....	155	138,295	32,356	4/	108,171

n.a.--Not available.
1/ Mileage shown in nautical miles based on Coast Guard figures.
2/ 16,843 miles of low frequency jet routes phased out of the airways system beginning in 1961.
3/ 7,297 miles of positive control route segments were eliminated from the airway system with the introduction of Area Positive Control.
4/ Airways restructured into two levels, eliminating intermediate altitude routes.

NOTE: Positive Control Route Segments (7,297 miles) excluded from low altitude direct airways in 1960 and from the intermediate altitude airways when encompassed by the intermediate in April [illegible], also [illegible] low and medium frequency jet route miles excluded.

SOURCE: FAA Statistical Handbook of Aviation

TABLE 2. US Air Route Airway Mileage: 1970-1979[54]

(Contiguous 48 States)

December 31	Very High Frequency VOR/VORTAC		
	Low Altitude		Jet Routes
	Direct	Alternate	
1970	140,268	33,215	112,662
1971	142,093	33,274	114,373
1972	143,241	33,436	117,417
1973	144,578	32,999	119,672
1974	144,939	32,999	122,372
1975	148,834	32,320	123,258
1976	150,172	31,888	130,160
1977	152,947	31,270	131,968
1978	155,242	31,235	134,709
1979	157,853	31,625	135,920

NOTE: Mileage shown in nautical miles based on National Ocean Survey figures.

SOURCE: FAA Statistical Handbook of Aviation, Calendar Year 1979

The less sophisticated low-frequency routes were [illegible] more effective VOR, and combination VOR and tactical [illegible] routes were developed. A three-level route structure was [illegible] 1961 but revised to a two-layer system in 1964. [illegible] have a third dimension (altitude), each horizontal mile [illegible] multiplicative effect on total airway space available. [illegible] ways are stacked vertically. Nonvisual traffic on jet routes [illegible] altitude) has 11 stacked two-directional "highways" [illegible] many as 7 in the low altitude structure (depending on [illegible]). [illegible] can visualize this system by thinking of a bridge with two levels and one-directional traffic at each level; say a "To" lane above and a "From" lane below. Air highways are like this, with additional lanes added vertically to the system. Both tables indicate a fairly constant and steady growth of VOR/VORTAC routes after rapid growth and a system adjustment in 1960. The phaseout of low-frequency routes and the increase in jet route mileage demonstrate a constant improvement in equipment and system capabilities.

The improvement of these navigation systems did not come without controversy, even though the goal of the Air Navigation Development Board (ANDB) was a common system. Two systems were developed simultaneously that had essentially the same capabilities: civilian VOR, with distance measuring equipment added, and the military tactical air navigation (TACAN) system. They were set up at the same time, and areas covered and system capabilities overlapped. The VOR system was not suitable for military use since it was not satisfactory for use at sea or in areas of active military operations.[55] Finally, a compromise decision by the Air Coordinating Committee allowed development of a common VORTAC system after nearly 10 years of duplicative effort.[56]

Traffic Control Centers

As early commercial aviation developed with larger and faster aircraft, it became clear that increased efficiency and safety were critical to further airline development. The increasing number of airline flights--especially around certain terminal areas--plus the necessity to keep schedules even in poor weather were rapidly increasing the potential for midair accidents. The first traffic control centers were established by the airline companies in December 1935. The Newark, New Jersey, office was first, followed by Chicago and Cleveland offices in the first half of 1936. The Bureau of Air Commerce took control of these centers soon after they were established, and they were operated by the military until 1938.[57] In the next 22 years, another 27 centers were established.[58]

Technology Integration

The methods and capabilities of air traffic control expanded rapidly. Initial radio communication networks were started in 1928 along airway routes. Cleveland Municipal Airport established radio control of airport traffic in 1929.[59] Rapid advances were spurred by World War II. In 1945, work began on adapting military radar systems to civil aviation.[60] Improved radar devices were used in the new Indianapolis airport control tower. In that same year, CAA controllers began using the radar ground controlled approach (GCA) system, which the military had developed in World War II. Long-range use of radar for civil air traffic control started in Washington Center in 1951 using jointly developed military equipment. The longer range system was to be used also for Air Force all-weather control defensive purposes.[61]

Aircraft beacon development began during World War II to help distinguish between friendly and enemy aircraft. Its further development in the late 1950s helped to improve and to expand radar control capabilities by expanding usable radar ranges and reliability.[62]

The CAA leased a computer in 1956. The purpose was to see if computers could be effectively used in air traffic control. By May 1959, computer systems were being purchased for use at five centers. These general purpose computers were generally used to aid air traffic controllers in "bookkeeping chores."[63] The first solid-state, real-time computer was put in service in July 1963. Since that time, the air traffic control computer system has become very sophisticated. For example, the FAA's computers are used to display a warning to controllers when an aircraft goes below minimum safe route altitude. Data such as aircraft identification and altitude are automatically displayed on controllers' radar scopes.

Civil Versus DOD Growth

The roles of military and civilian organizations in the development of the NAS are important to this study. At times, each has provided the lead in system development. We have seen, for example, that radar was developed and first used by the military. The airline companies actually started the first traffic control centers. At other times, there has been competition in developing systems. An example was the development of two competing systems, TACAN and a civilian VOR system, which had essentially the same capabilities. There are, of course, other aspects of the military and civilian roles in the growth of the NAS. Some of these are discussed below.

Early in aviation history, it was evident that the federal government should play a role in fostering and regulating civil aviation. This

was in the public interest. Yet, government involvement in any activity must always be balanced in a democratic society. The debate over passage of the Federal Aviation Act of 1958 highlighted the concerns of the three main user groups of national airspace--commercial, military, and general aviation. The legislative process had to deal with the dilemma of how ". . . to most effectively manage a function generally accepted as a responsibility of the government and yet, at the same time, do so in such a way as to interfere least with the cherished rights of individuals."[64]

The public interest in the management of national airspace has many aspects. Because of the increasing potential for air disasters, air safety became the main concern of government. But there are other key items of public interest in the management of the NAS. The commercial use of airspace is to be fostered. Military use of airspace is to be assured in recognition of the needs of national defense in peace and wartime. General (or private) aviation's right to use airspace is to be guarded in defending the rights of individuals to use the public domain. The health of the private flying sector is also to be nurtured because of its impact on the nation's economy.

The FAA must balance the needs of all users in the public interest. This difficult task is made even more complicated by the constantly changing needs of the users. The relative growth of each user group has changed over the years, and there has been a different rate of growth in sophisticated aircraft and equipment even within the groups themselves.

Comparative Growth Factors

Few aircraft were built in this country prior to World War I. About 70 percent of the 681 aircraft produced from 1913 to 1916 were for

civilian use. By the end of the war, nearly 17,000 more planes were produced of which 98 percent were military.[65] After the war, many of the surplus aircraft were purchased by private flyers. Civil and commercial aviation, first supported by mail contracts, grew between World War I and World War II while military aviation growth was sluggish until the late 1930s.[66] As shown in Table 3, World War II produced massive military growth again in comparison to civil aircraft.

Between 1945 and 1950, civil aircraft production initially surged in comparison to military aircraft production. Most of the civil aircraft built were general aviation aircraft. There were about 65,000 civil aircraft produced in the United States during the period,[67] and the air carrier fleet grew by only about 550 aircraft.[68] In 1952, there were about 53,000 active civil aircraft in the CONUS[69] of which about 1,000 were operated by scheduled air carriers. The Air Force with its Reserve forces had about 10,000 aircraft in the CONUS.

The relative demand for service from the FAA between World War II and now can be seen in Figure 9, which shows the number of tower operations provided at FAA-operated control towers. Total operations have gone from just over 16 million to nearly 70 million per year. General aviation usage has had marked growth while the trend for air carrier usage has not grown as fast. The military demand has always been the smallest and has shown a declining trend since the late 1950s.

TABLE 3. United States Early Aircraft Production

1913-1947

Year	Number of Aircraft		
	Total	Military	Civil
1913......	43	14	29
1914......	49	15	34
1915......	178	26	152
1916......	411	142	269
1917......	2,148	2,013	135
1918......	14,020	13,991	29
1919......	780	682	98
1920......	328	256	72
1921......	437	389	48
1922......	263	226	37
1923......	743	687	56
1924......	377	317	60
1925......	789	447	342
1926......	1,186	532	654
1927......	1,995	621	1,374
1928......	4,346	1,219	3,127
1929......	6,193	677	5,516
1930......	3,437	747	2,690
1931......	2,800	812	1,988
1932......	1,396	593	803
1933......	1,324	466	858
1934......	1,615	437	1,178
1935......	1,710	459	1,251
1936......	3,010	1,141	1,869
1937......	3,773	949	2,824
1938......	3,623	1,800	1,823
1939......	5,856	2,195	[1]3,661
1940......	12,804	[2]6,019	[1]6,785
1941......	26,277	[2]19,433	[1]6,844
1942......	47,836	[2]47,836	([3])
1943......	85,898	[2]85,898	([3])
1944......	96,318	[2]96,318	([3])
1945......	49,761	[2]47,714	2,047
1946......	36,670	1,669	35,001
1947......	17,717	2,109	15,617

[1] Represents domestic civil only; data on new aircraft produced for export not available.
[2] Includes United States-financed aircraft manufactured in Canada.
[3] No production other than military.

Table 3 Sources:

1913-24--"Air Commerce Bulletin," Vol. 1, No. 5, p. 6, Consumption.

Military aircraft data:

1925-37--Aeronautical Chamber of Commerce, "The Aircraft Yearbook," 1916, p. 454; 1938, p. 442.

1938-39--Munitions Board, Department of Defense.

1940-45--"US Military Aircraft Acceptances 1940-45," Department of Commerce, Civil Aeronautics Administration.

1946-47--Statistical Control Division, Office of Air Comptroller, Department of the Air Force; and Production Branch, Bureau of Aeronautics, Department of the Navy. Military aircraft data for subsequent years not published for security reasons.

Civil aircraft data:

1925-45--CAA Semiannual Production Reports.

1946-47--CAA Census Bureau: "Facts for Industry." Series M42A on shipments of complete aircraft.

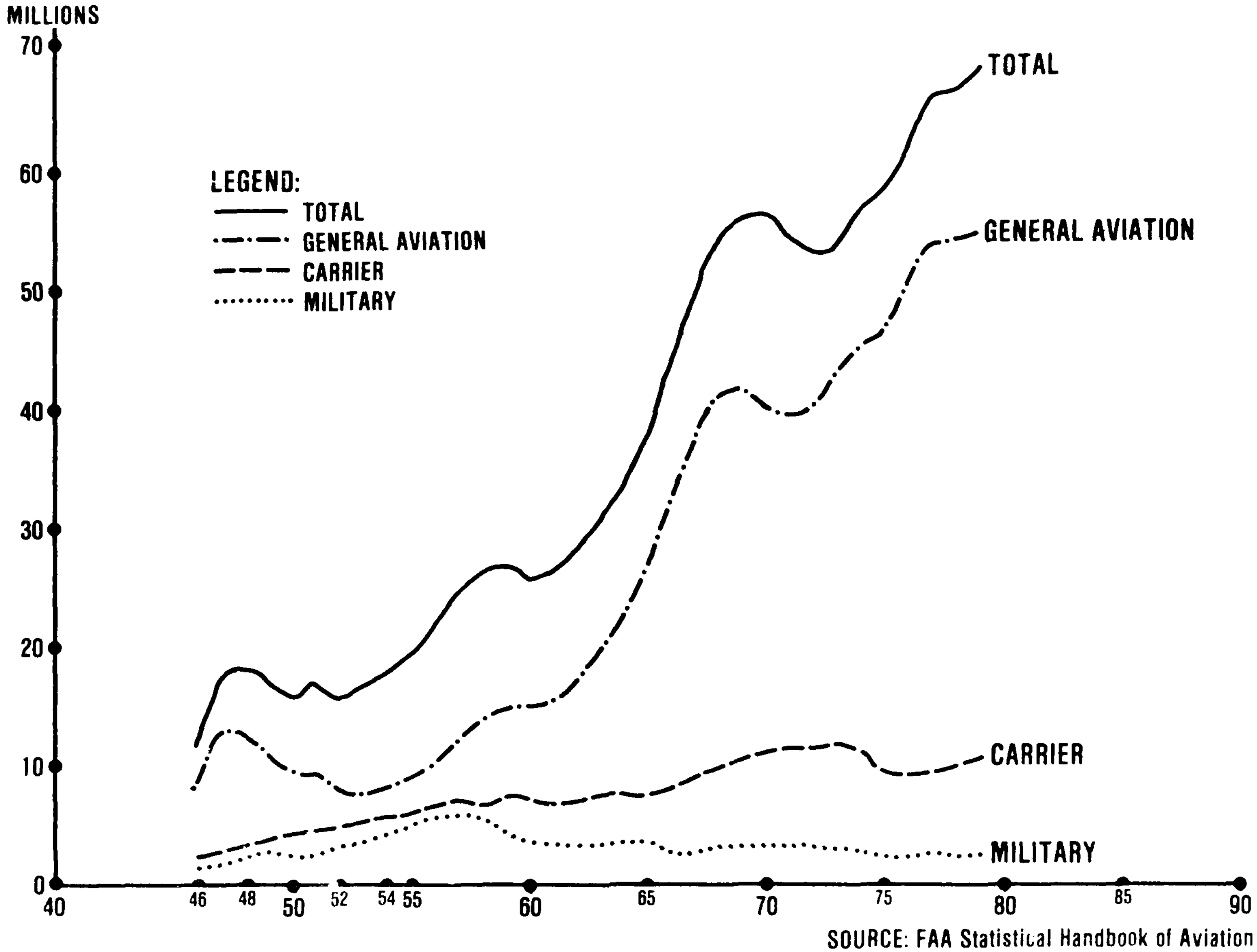
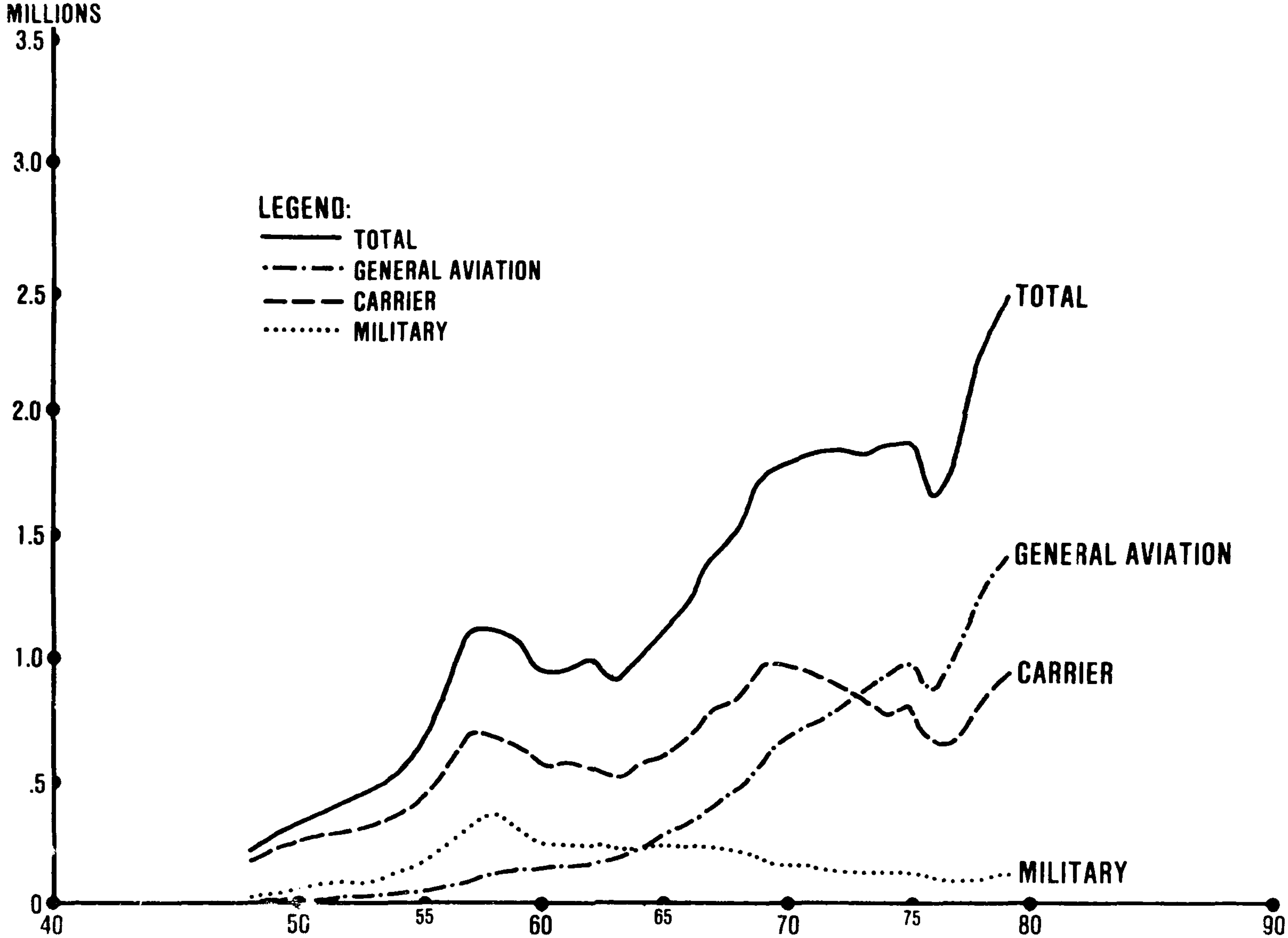


Figure 9. Past Trends in Tower Operations (Millions)

The trends in instrument approaches flown are shown in Figure 10. They demonstrate how the demand for more sophisticated services in terminal airspace has been changing. Just over 300,000 instrument approaches were recorded in 1950. Nearly 2.5 million were recorded in 1979, showing a rising trend. Commercial and general aviation showed increasing trends while military aviation has declined from the late 1950s. Commercial aviation used the most approaches until the early 1970s when general aviation passed it in the use of instrument approaches. General aviation had passed military operations in the mid-1960s.

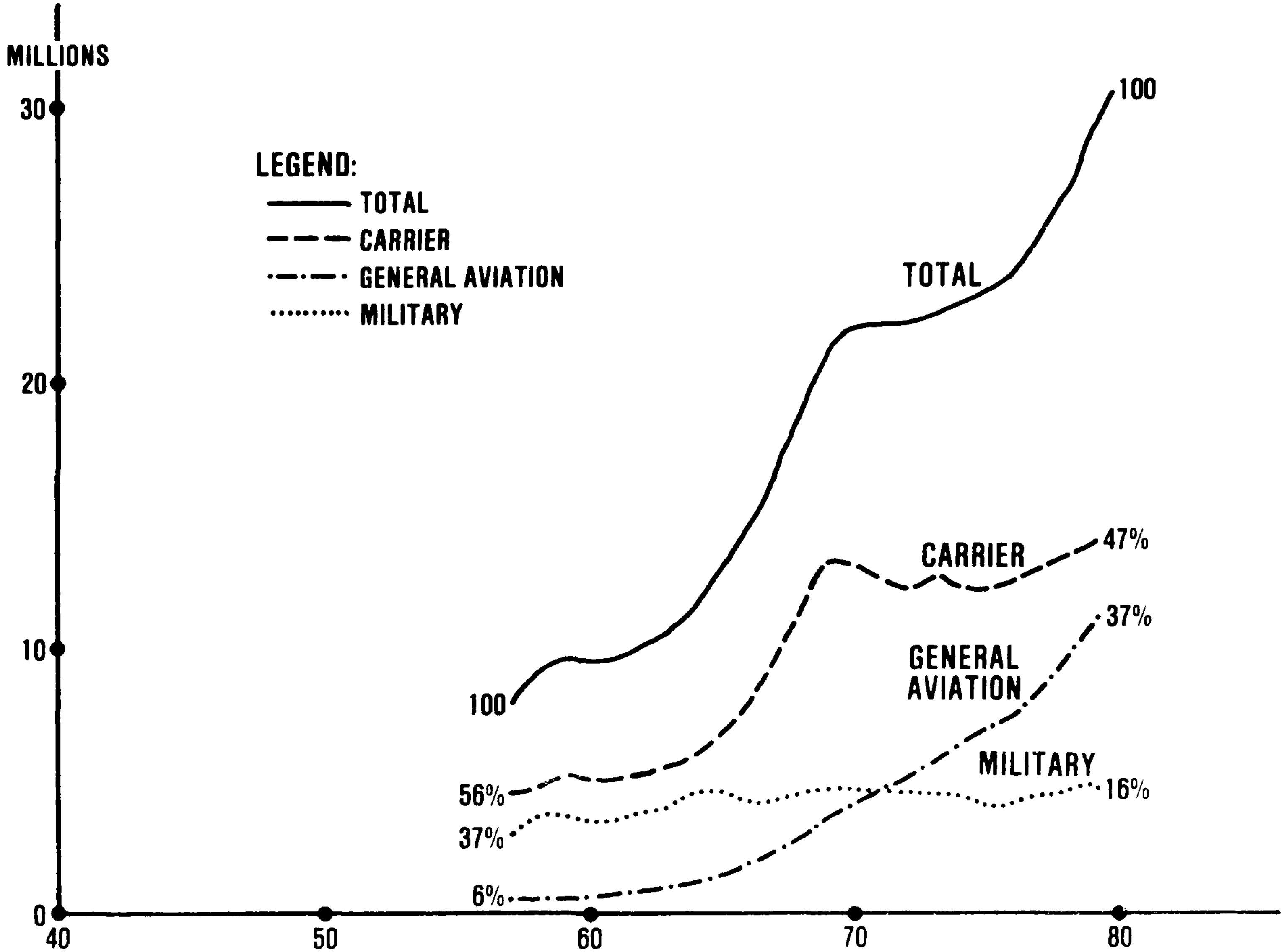
For a broader picture of how the requirements for instrument services have changed, see Figure 11, which lists the volume of instrument flight rules (IFR) traffic handled by FAA centers over the last 20 years. The total requirement has had constant, rapid growth while the relative rates of growth of the user groups have varied somewhat. The total military requirement has been static but has become proportionally smaller. Air carrier and general aviation requirements for service have grown. The general aviation requirement shows a significant growth trend which surpasses military requirements in the early 1970s and approaches airline requirements toward the end of the period.

In terms of FAA services used, general aviation's growth to become the largest user of the NAS is seen in the last three figures. Steady growth in all civil aviation is noted along with a slight decline or stagnation in military use. This decline in military flying highlights a need to make the most efficient use of the limited flying time available.



SOURCE: FAA Statistical Handbook of Aviation

Figure 10. Past Trends in Instrument Approaches (Millions)



SOURCE: FAA Statistical Handbook of Aviation

Figure 11. Past Trends in FAA Center IFR Traffic Handled

Rivalries

The responsibility, or right, to allocate and to control the NAS has been disputed often. The original development of two separate systems, one military and one civil, attests to this. The Air Coordinating Committee's composition of representatives from the Departments of War, Navy, and Commerce had no clear-cut leader. Disagreements about whether to use VOR or TACAN navigation aids and GCA or instrument landing system (ILS) terminal approach aids demonstrate the military versus civilian rivalry that has existed.[70] The fact that military operations should be given priority during national defense emergencies is generally agreed upon. Furthermore, flying safety and economic efficiency dictate a single integrated system. The problem is how to equitably and efficiently manage the NAS in the national interest.

This problem is a very complicated one. The interests to be balanced go beyond civil aviation versus DOD. Within civil aviation, there are factions of commercial aviation versus general aviation. In the early years, there was intense Army versus Navy rivalries within the military establishment resulting in the famous Billy Mitchell affair.[71] There was the problem of making legislation that would encourage growth of aeronautic enterprise without giving it unfair advantage over other types of business and transportation enterprise. And finally, there were differences between the executive and legislative branches of government about how aviation matters should be handled.[72]

In fact, the management needs of the NAS are dynamic. The approach must be changed and updated as the system develops methods to best serve the public interest in support of safety, national defense, and economy. A balance between all three is crucial.

Air Training Command Interface

The last step in the review of the development of the NAS structure is an overview of ATC's interface within the NAS. This will include how the command originally operated in the visual flight rules (VFR) environment and the transition to an IFR training environment, which dictated changes in special-use airspace requirements and generated special equipment needs. Finally, it includes the unique airspace requirements of ATC.

From 1941 through 1945, nearly 200,000 pilots were trained by the Army, over 88,000 of them in 1944 alone. The aircraft used varied from the PT-13 to the P-40 and B-25.

After the war, training rates dropped drastically to as low as 541 in 1947. Since the beginning of the Korean conflict in 1950, annual pilot training rates have ranged from a high of almost 7,000 in 1955 to a low of a little over 1,000 in 1979 (see Table 4).[73] More recent trends show a need to train over 2,000 new pilots each year. The total pilot force size was reduced from about 57,000 in 1957 to about 22,000 in 1978. The result was that the Air Force had more pilots than required except during the Vietnam conflict. More recently, training rates have increased to replace high pilot losses and to meet and to sustain a growing force size.

TABLE 4. Fixed-Wing Undergraduate Pilot Production

(FY 1941-79)

STANDARD COURSE						GERMAN AF (GAF) COURSE	
FY	AAF/USAF	ANG/AFRES	US OTHER	FOREIGN	TOTAL	USAF	GAF
1941	3,393				3,393		
1942	14,279			2,102	16,381		
1943	46,766		66[a]	2,604	49,436		
1944	86,578		705	758	88,041		
1945	40,759		303	995	42,057		
1946	4,925			980	5,905		
1947	369			172	541		
1948	701			29	735		
1949	813			29	842		
1950	2,100			13	2,113		
1951	2,031			88	2,119		
1952	2,718			405	3,123		
1953	5,265			735	6,000		
1954	4,754			1,041	5,795		
1955	5,841	318		693	6,852		
1956	5,702	351		195	6,248		
1957	5,726			122	5,848		
1958	3,980			181	4,161		
1959	2,483			191	2,674		
1960	2,185			102	2,287		
1961	1,795	47		294	2,136		
1962	1,300	62		214	1,576		
1963	1,433	58		209	1,700		
1964	1,675	115		127	1,917		
1965	1,992	126		133	2,251		
1966	1,889	177		118	2,184		
1967	2,702	133	3[b]	158	2,996		
1968	3,063	157	15	65	3,300	21[c]	137
1969	3,137	142	125	75	3,479	79	90
1970	3,454	156	169	123	3,902	67	111
1971	3,809	169	199	145	4,322	68	77
1972	3,718	189	5	205	4,117	83	74
1973	2,723	363		208	3,294	87	56
1974	1,990	183		175	2,348	102	67
1975	1,910	159		153	2,222	37	68
1976	1,615	73		116	1,804		74
197T[d]	371	24		26	421		[illegible]
1977	1,263	83		54	1,400		80
1978	1,031	94		46	1,171		[illegible]
1979	993	88		51	1,132		85

Table 4--Continued

a Figures in this column from 1943 to 1945 are 1,074 Women's Air Force Service Pilots.
b Figures in this column from 1967 to 1972 are 504 Marines and 12 National Aeronautics and Space Administration (NASA) civilians.
c During 1968-75, a total of 544 USAF personnel graduated from GAF UPT at Sheppard AFB, Texas.
d FY 197T was a 3-month transition period (Jul-Aug-Sep 1976) to allow following fiscal years to begin on 1 October.

SOURCE: Major Changes in Undergraduate Pilot Training, 1939-1979

ATC has, and continues to teach, many courses besides those shown in Table 4. For example, conversion courses for both helicopter to fixed-wing and fixed-wing to helicopter pilots have been taught in the past at Sheppard AFB, Texas. Fixed-wing conversion training is now distributed among the UPT wings. Many advanced navigator training courses have been, and continue to be, taught at Mather AFB, California.

The aircraft fleet used by ATC for UPT has evolved to an all-jet, high-performance one since World War II. P-80 jets were first used in the last part of 1948. The T-33 jet trainer was introduced in late 1950. By 1956, all jet basic training was accomplished with the T-33. In 1958, the T-37 was being integrated into ATC's inventories; and by March of 1961, pilot training was an all-jet course with the T-37 used for primary training and then the T-33 or T-38 for basic training. In 1966, the current command aircraft, T-37s and T-38s, were being used exclusively for primary and basic training.[74]

The change in aircraft used, particularly in terms of increased performance, is one of many factors affecting how the command has fit into the NAS. Other factors are changes in NAS capabilities, relative user growth, advancing technology, and Air Force policy.

Until 1958 in the advancing "jet age," meteorological conditions such as clouds and fog were the main limitation on being able to see other

aircraft. The "positive control route segment" was designated in 1958 by the FAA because the extreme closure rates of high performance aircraft had outdated the concept of "see and be seen" which was primarily used in the NAS as well as ATC at that time.[75] With the increasing aircraft speed, collisions could occur without the aircraft pilot having time to react. The NAS had to be changed to meet the changing needs of the system users. The concept of positive radar control of all high-altitude, high-performance aircraft was expanded through the mid-1960s.

Originally, Training Command pilots flew under VFR where they depended upon their eyes to keep from colliding with other aircraft. As the command began to use T-33s (early 1950s), airspace was segregated by type of mission--separate areas for contact, instrument, and formation missions. By the late 1950s, restricted airspace was identified as a command requirement. In the early 1960s, as the T-37 entered the command inventory, similar segregation arrangements had to be made. As the T-38 appeared in the early 1960s, special operating areas (SOAs) were needed in the higher positive control area. Below this, intensive student jet training areas (ISJTAs) replaced the restricted areas. The SOAs were replaced by FAA radar control at the higher altitudes in 1965.[76] In the lower areas, the ISJTAs were ultimately replaced by military operations areas (MOAs) as radar control of ATC's flying programs was implemented.

The above progression moved to segregated special-use flying areas as the higher performance jet aircraft were integrated into ATC's programs. Then, as the FAA's radar controlling capacity was developed, the command was integrated into the FAA system and gave up the restrictive use of national airspace. This move, which was in line with the national policy of the

particular era, resulted in a common military-civil system to enhance flight safety and to reduce special-use airspace as much as possible.

The Air Force provided funds to the FAA for the necessary equipment and, initially, personnel to support ATC operations. It was also necessary to buy distance measuring equipment (DME) and radar transponders for the T-37 fleet so it could be given radar control by the FAA.[77] Funds for these actions were slow in coming because of the Vietnam conflict. The first ATC base to be fully controlled by the FAA was Randolph AFB, Texas, in May 1972; and the last base in use today to become fully controlled was Williams AFB, Arizona, in July 1975.

As do many other military flying activities, ATC has many unique airspace requirements. The typical training sortie is not designed to go merely from point A to point B. Besides learning basic flying skills, the military student pilot is establishing the judgment required to use a flying machine as an instrument of war. All male students are potential combat fighter or bomber pilots. They must learn to safely and efficiently fly their aircraft to a desired point, accomplish unique maneuvers (comparable to such missions as weapons delivery), and get back home. (Operational missions might require low-level, high-speed navigation, formation tactics, or instrument flight for weather penetration.) All this is done by student pilots in relatively high-performance aircraft, and it is quite different from a civil-type transportation flight from point A to point B.

At the home base, the training mission requires students to practice many landings, making ATC bases resemble a "beehive." The number of operations at command fields are nearly as numerous as the busiest civil fields in the country.

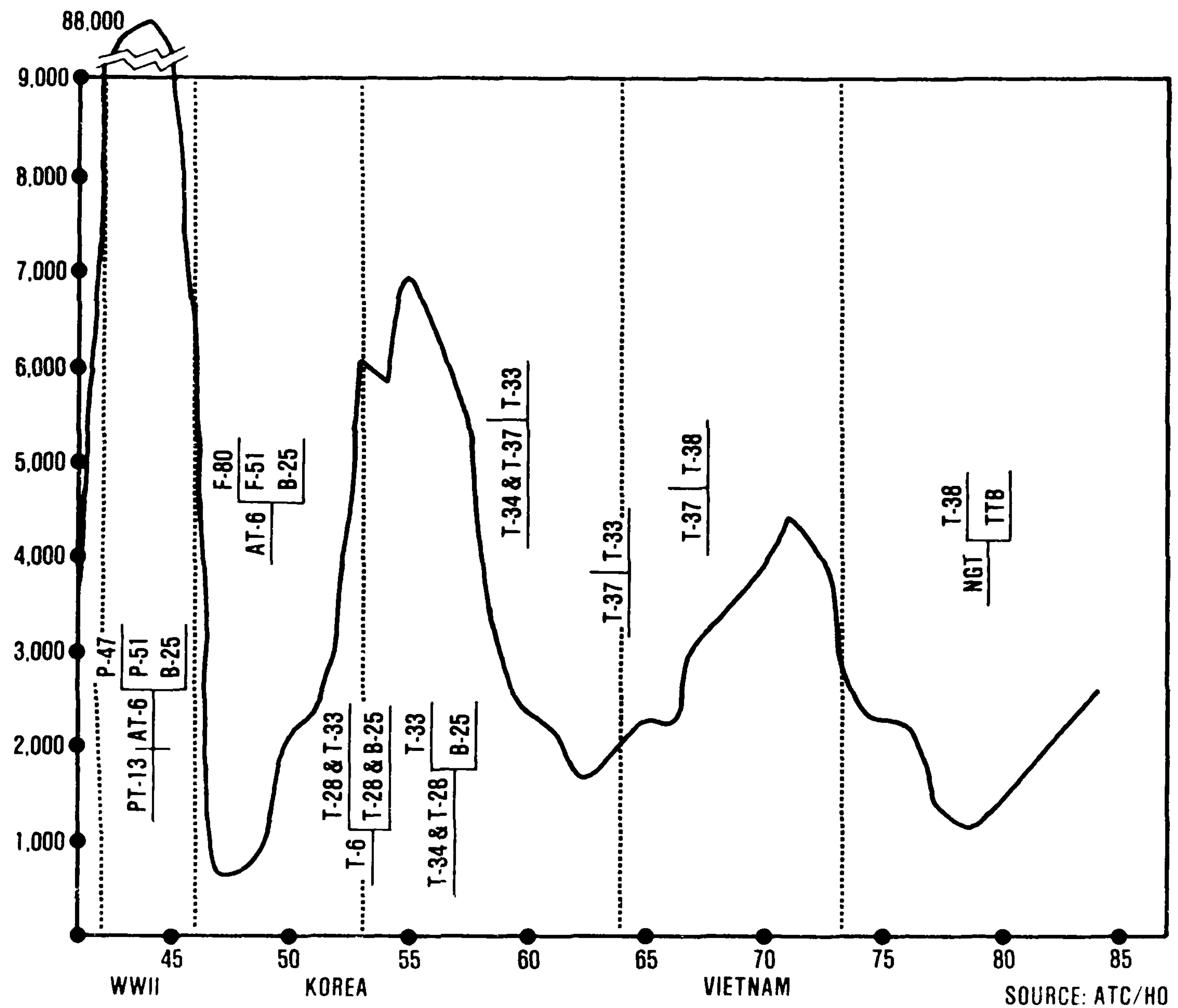


Figure 12 ATC Training Rates and Equipment

Because initial basic flying skills must be learned and honed by students, most flying activity around command bases is done during daylight hours, and little flying is accomplished when weather is poor. This is unique to ATC's flying operations. When periods of poor weather cause delays in the training program, intensive "catchup" operations are often required. There is little flexibility available in the training system, especially when training rates are near command limits.

Figure 12 illustrates the large fluctuations in training rates experienced by the command. This, along with technological advancements such as the addition of simulation to the training program and a dynamic evolving training syllabus, makes evident the fact that the command has changing requirements.

Summary

In summary, this chapter has given an overview of the NAS structure development. It is certainly not intended to be inclusive, but it should set the tone for how the system got the way it is.

The FAA is responsible for a single system of airspace control and management which evolved from two separate systems--one military and one civil. It is evident that in the interest of safety, there must be a single system and manager.

The FAA has the very difficult task of balancing the needs of three main user groups--military, commercial, and general aviation.[78] It must serve the public interest and the government's responsibility by efficiently fulfilling needs during peacetime as well as national emergencies. Peacetime military training, for example, requires a unique system of

airspace allocation and control. However, the NAS computer is designed for point-to-point flights.[79] This type of system best supports commercial aviation. Government regulations and support of commercial aviation have been vital to the economic development of this country.[80] A robust aviation industry is in the public interest because it strengthens the economy and thus benefits national security and defense. The FAA must also provide the safest and least restricted environment possible for the general aviation airspace user. The health of the general aviation sector is also important to the nation's economy since over half of its aircraft is used for business purposes.[81]

The NAS growth had to be extremely rapid since aviation growth has been spectacular. NAS development has barely been able to keep up with the demands created by technological advances resulting from World War I, World War II, the jet age, and more recent developments.

ATC's experience parallels NAS development. Rapid advances in technology were integrated into the training system rapidly, and the command has fit into the NAS as best it could. But it is time to look to the future.

The remainder of this document examines the future needs and capabilities of the NAS as well as the future needs of all users. Then options for ATC are formulated. The hope is that future development of the NAS can be guided so that a more effective, safer system is developed to serve the needs of all users. The goal is to determine what can be done now and in the future to fit ATC most effectively into the future NAS.

CHAPTER II

FUTURE CIVIL REQUIREMENTS AND NAS PLANNING

In Chapter I, an overview of the history of NAS development was presented. This chapter proceeds with forecasts of future civil trends within the NAS. This includes forecasts of civil needs converted to the FAA workload along with the FAA philosophy and plans for the future.

Limitations and Assumptions

Since this study is primarily a long-range planning effort, the limitations associated with forecasting future events must be clarified before the future NAS environment is examined in the next three chapters. Historians do not always agree when describing the facts as they have occurred. Certainly, those who look into the future cannot be expected to do any better. In fact, no realistic forecaster expects to be exactly correct about the future, which is why forecasts are frequently given as a percent chance (as in weather forecasting) or as a range of possible outcomes.

As a forecast goes further into the future, its reliability is reduced or the range of forecast outcomes is increased. This is the reason why little about the future is certain, and the chances that an unexpected event would alter a forecast are greater as time passes. Roy Amara, president of the Institute for the Future, says, "Anything you forecast is by definition uncertain."[1]

Since uncertainties exist, this study of the future NAS should be viewed with this constraint. However, much useful information has been obtained which makes this effort beneficial. The insights developed will

help in making plans for the future, which is certainly better than not planning at all. In fact, the future is changed by the planning efforts and actions taken today.[2] For this reason, a look into the future will suggest what near-term actions might be taken to enhance ATC's airspace situation in the future as was pointed out by General Ryan, commander of ATC, during a review of this project.[3]

Inherently, assumptions about the future have to be made in order to make any forecast. This contributes to the forecasting deviation previously mentioned. For example, the FAA aviation forecasts for Fiscal Years 1981-92 use the Wharton Econometric Forecasting Associates, Inc., projection of key economic variables.[4] Yet these variables, such as gross national product and civilian population employed, are sure to vary somewhat from the projections.

Although not explicitly stated, this study makes certain assumptions about the course of future events. One such assumption is that this country will not be involved in any major conflict, and the projections of this study do not include one. The starting point, therefore, is the world environment of today, and the assumption is that peacetime operations will continue. Although not included in future projections, ATC's ability to support future surge or wartime training demands will be considered as well as peacetime training requirements to simulate wartime training environments. The guidance, policies, and proposals set forth in Secretary of Defense Caspar W. Weinberger's Annual Report to Congress, Fiscal Year 1983 are the primary basis for future DOD planning assumptions.[5] These assumptions, as well as those about economic and demographic variables, are that the present situation will change. The environment is not static.

However, the projected changes of the planning variables are based on a realistic, fairly constant view of the future.

Areas of Uncertainty

In the short term, the strike by the Professional Air Traffic Controllers Organization (PATCO) limited the NAS capacity. The assumption is that the impact of the strike will be overcome by the mid-1980s. Air traffic control services and system capacity should be nearly normal by the end of 1982 except for limitations at some of the nation's busiest airports. Total capacity should return by the end of the next year, and growth potential should return sometime in 1984.[6]

Probably more important than system capacity is the reestablishment of normal relations between air traffic controllers and FAA management. PATCO was established on 3 January 1968.[7] In June of 1969, a controller "sick-out" was conducted that was encouraged by the organization.[8] PATCO called for a larger work stoppage in March and April of 1970.[9] Hence, the history of problems between FAA management and air traffic controllers began early. Bringing the traffic control system back to normal does not necessarily cure the underlying problems that caused the most recent strike. Until these problems--stated by the National Transportation Safety Board--are solved, there is a potential for more system disruption in the future.[10] Future FAA air traffic activity forecasts assume that since the major problems between the air traffic controllers and management have been identified, the system which is being rebuilt will not suffer disruption to system capacity as experienced in the recent past. Unfortunately, some uncertainty does exist.

Other areas of uncertainty exist too. In assessing the future status of the airline industry in the United States, James Ott, writing for Aviation Week and Space Technology magazine, makes the following observation: "Both deregulation advocates and opponents agree that the competitive environment unleashed by the Airline Deregulation Act of 1978 will rock the system through the 1980s and change it radically."[11]

The final balance between large trunk airlines, new and expanding commuter and charter airlines, and business use of corporate general aviation aircraft will not be known for some time. However, the traffic the carriers will be competing for in the next 7 or 8 years is forecast to increase about 5 percent annually.[12]

At this point, there is question about the future impact of advances in visual telecommunications upon the growth of corporate aviation. Some officials expect little impact while others are not so sure. They wonder if it will be necessary for a corporate executive to travel long distances to meet a client face to face "when in time he will be able to communicate via a visual system and even see the client twitch when he gives him a price on a particular item."[13] Almost all aircraft manufacturers seem to be optimistic about the future of their business; they expect the impact of telecommunications to be minimal.

With the limitations and uncertainties of looking into the future in mind, this chapter proceeds with a look at future civil aircraft requirements for airspace and at the planned FAA NAS development.

Future Situation

The future situation envisioned is one of population growth and of economic stability, with a continuing recovery and growth projected. The

world competition of today with a militarily powerful Soviet bloc and the emerging power and influence of the Third World is expected to continue.

The continued population growth and economic stability within this country will influence the demand for use of the NAS by all civil users. As a rule, both general and commercial aviation airspace demand should increase in the long term with the economic recovery. Reduced fuel prices in the near term caused by excess world crude oil production[14] also is a positive factor in air traffic growth.

Military demand for a share of the NAS will increase slightly in the future. This is based on the assumption that public and political support for a strong national defense posture will continue. Support will come from the growing public awareness of the military strength and political resolve of the Soviet bloc. Hence, the US military force structure, including military flying units, will grow.

The assumption is that factors increasing the demand will outweigh those that decrease the demand for airspace. In the long term, increasing fuel prices will be a negative factor tending to reduce the demands for airspace. Economic growth by developing nations will create a need for the current excess crude oil, which could be used up by 1990. These countries lack sufficient capital to develop alternative energy sources.[15] In the near term, a stagnant economy with high interest rates has reversed growth patterns in both commercial and private flying.[16] However, both large aircraft manufacturers and the airline industry are forecasting growth for the future.[17,18] Manufacturers of smaller aircraft used for general aviation flying are more uncertain about the future; however, "growth is expected to resume by 1983 with recovery from the general economic slump."[19]

Forecast of Civil Airspace Requirements

Civil aircraft airspace requirements come from the operations of commercial and general aviation aircraft. Commercial aviation consists of major air carriers, air taxi service, and commuter airlines. In addition, air cargo transportation should be included as a major factor in the spectrum of commercial aviation. There are also other commercial uses for smaller aircraft such as crop dusting (agriculture) and flight training. The airspace requirements for the last two are included with all general aviation aircraft. Other general aviation aircraft airspace needs are generated by pleasure and business flying. About half of all general aviation airspace requirements come from business travel.[20] Also, helicopter operations should be included in this group of general aviation users of airspace. These are all civil users of airspace.

The Changing Balance

The types of FAA service used, which reflect the portions of the NAS each user needs, vary among civil users. For example, commercial air carriers operate under IFR in the highly sophisticated, high-altitude jet route structure and within controlled terminal areas around the busy traffic hub areas. FAA services are provided by air traffic control towers to aircraft that are on and near the ground, low-altitude terminal facilities which control arrivals and departures, and en route traffic control centers. Flight service stations may also provide service to the commercial carriers. This air traffic control system evolved to serve the needs of the fast, high-flying, modern jet-powered aircraft used by commercial air carriers. So the airline aircraft use tower-controlled ground and

airspace, terminal airspace, and high-altitude en route (point-to-point) airspace extensively.

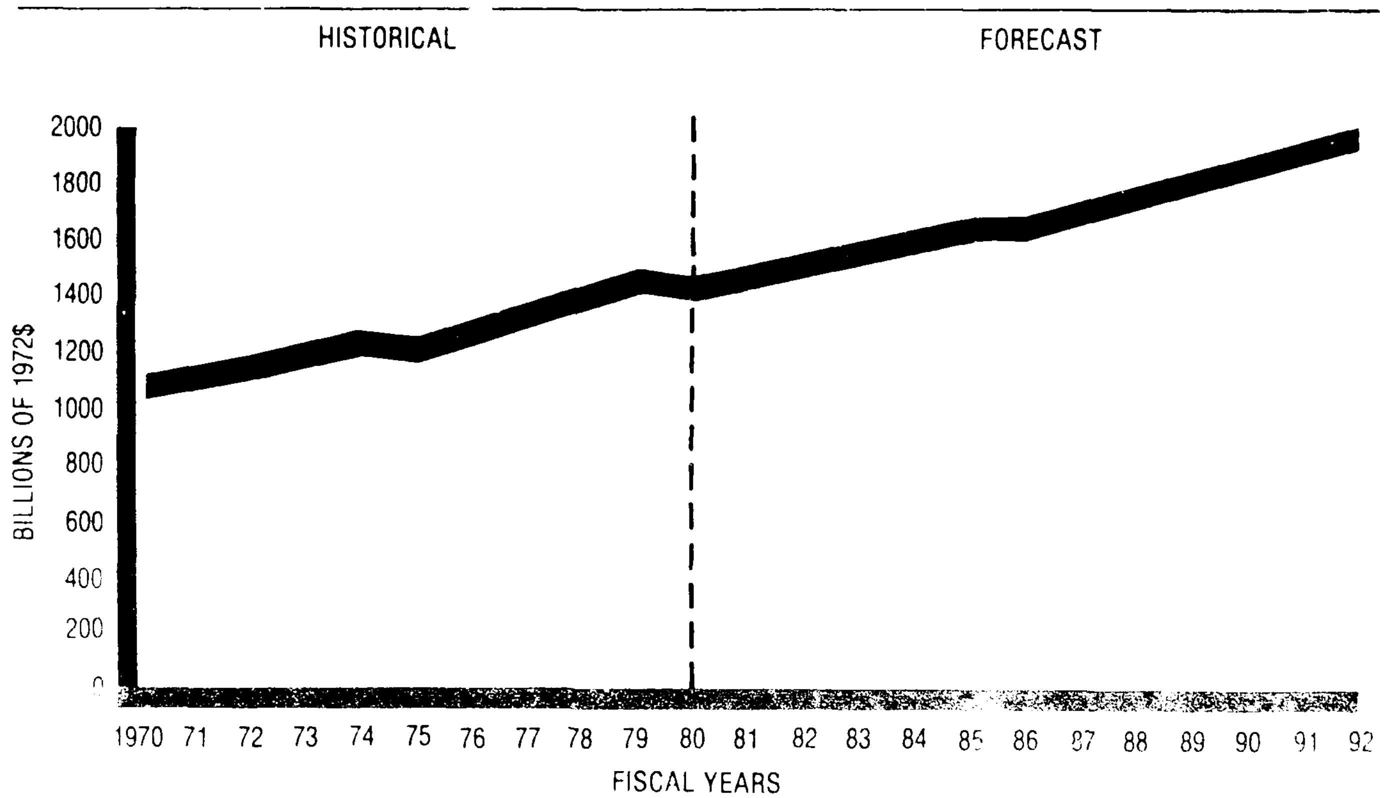
The air taxi operation may use the same services at times. However, the aircraft used are operated generally at lower en route altitudes. The smaller turbofan, turboprop, or piston engine aircraft are more efficient at lower altitudes. Also, the routes flown are normally shorter, thus reducing optimum altitudes flown. The routes flown are shorter and tend to be into smaller airports with a greater likelihood of visual flying and tower control use only.

Business and private general aviation aircraft are even more likely to be operating in the uncontrolled environment under VFR. However, the previous balance between requirements for airspace used and controller services is changing. "The once clear lines of distinction between 'trunk,' 'local service,' and 'commuter' airlines are becoming increasingly blurred."[21] This is due to the impact of the Airline Deregulation Act of 1978. Another impact of the act is reduced commercial service to smaller cities. This in concert with recent trends for movement of business centers away from large cities and the use of aircraft as a business tool[22] has increased the diversity in the demand for airspace and FAA service throughout the country. A balance is yet to be established. Yet the forecasts of aviation activity have been made and are fairly reliable. These forecasts made by the FAA are based on future economic variables.

Forecasting Variables

The economic projections used to establish FAA baseline forecasts were prepared from the Wharton Long-Term Industry and Economic Forecasting model. Figure 13 shows the historic and forecasted gross national product

FIGURE 13. GROSS NATIONAL PRODUCT



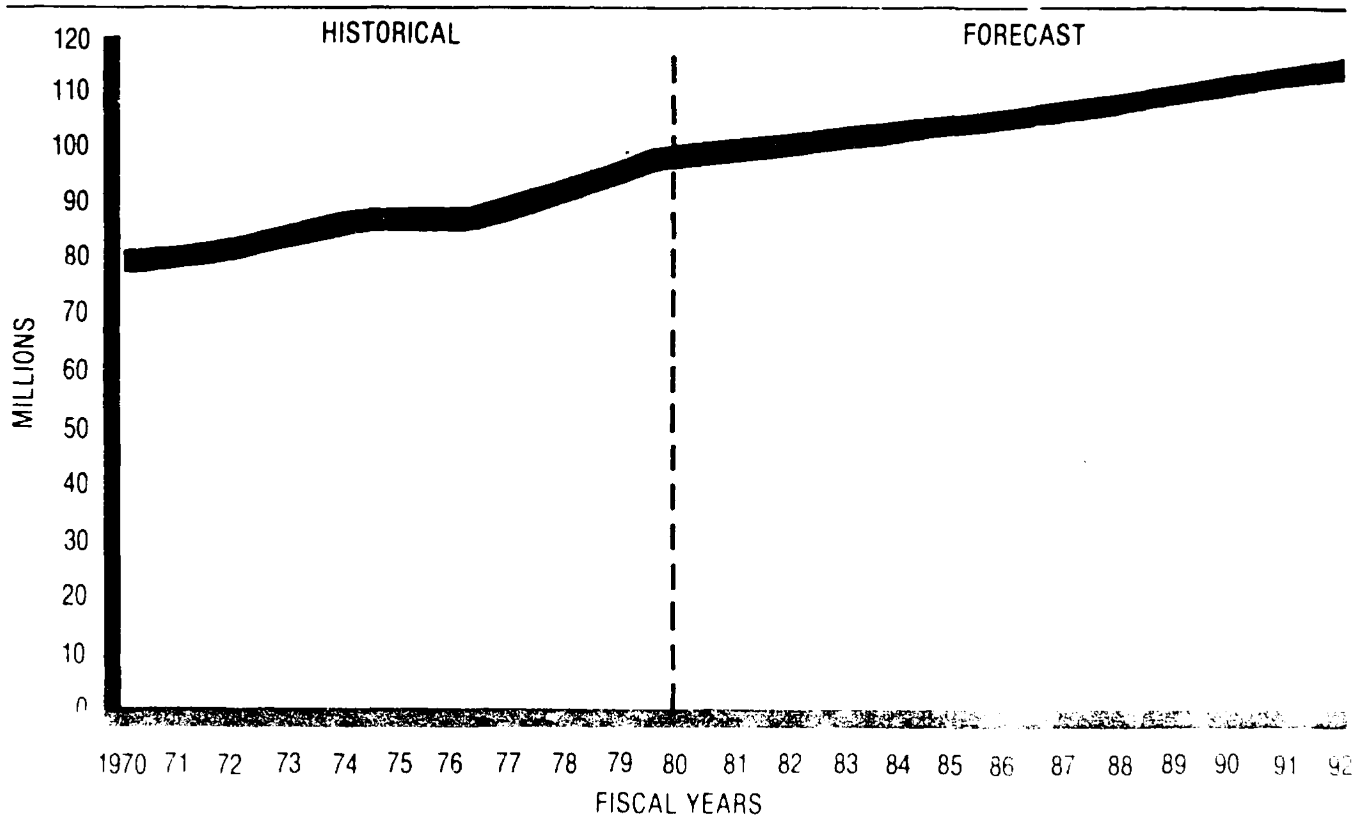
SOURCE: FEDERAL AVIATION ADMINISTRATION

(GNP) in 1972 dollars. The projected average annual growth rate is slightly lower than the Fiscal Years 1976 to 1980 average--2.7 percent compared to 3.1 percent.[23] The growth in GNP is a positive reflection of the basically strong economic base in this country. This should be a positive factor in the future requirement for airspace by civil users. (Table 5 lists the data demonstrated in Figures 13 through 17 and follows Figure 17.)

Next, Figure 14 gives the historic and projected numbers of people employed. Employment is expected to increase steadily through Fiscal Year 1992. The forecast is for an average annual rate of increase of 1.3 percent, which is less than the historic rate. This is due to a shift in population age distribution--fewer people will be entering the labor force.[24] Also, the large-scale entrance of women into the labor force influenced employment rates prior to 1980.[25] Increasing employment will be another positive factor in the demand for airspace and air traffic control service influenced through the demands of commercial air carriers and general aviation.

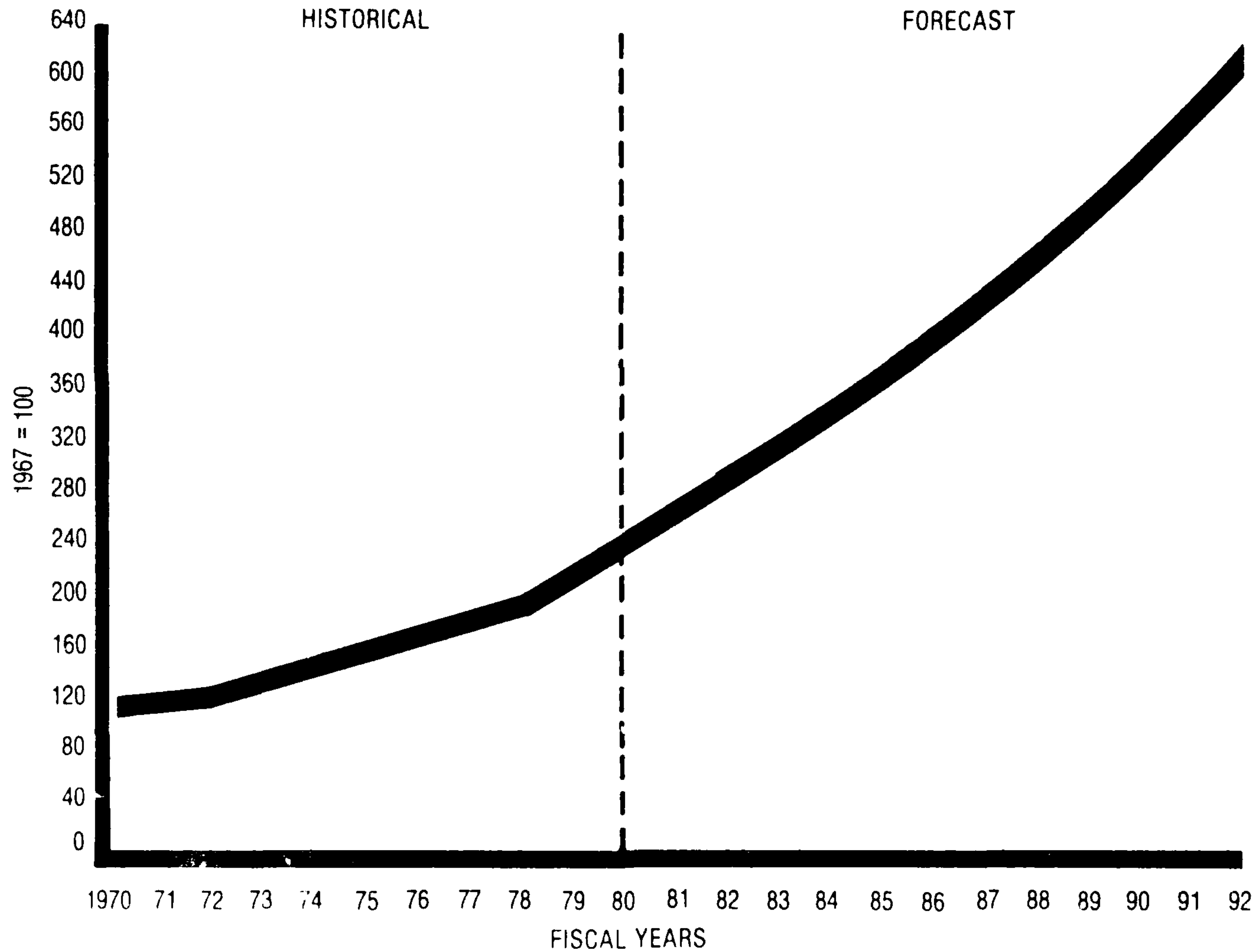
FAA forecasts also use the consumer price index and the projected amount of disposable personal income as baselines to develop FAA forecasts. Figures 15 and 16 show the historic data and forecasts for these two variables that were used by the FAA. The forecast is for consumer prices to continue to rise but at lower rates of about 7.3 percent by 1992. A declining consumer purchasing power has a dampening effect on the aviation industry. Disposable personal income is expected to grow at a 2.8 percent rate between 1980 and 1992. Greater amounts of disposable income in consumption patterns due to expected relatively higher fuel and energy costs have created some uncertainty about the total effect.[26] A strong economy

FIGURE 14. EMPLOYMENT



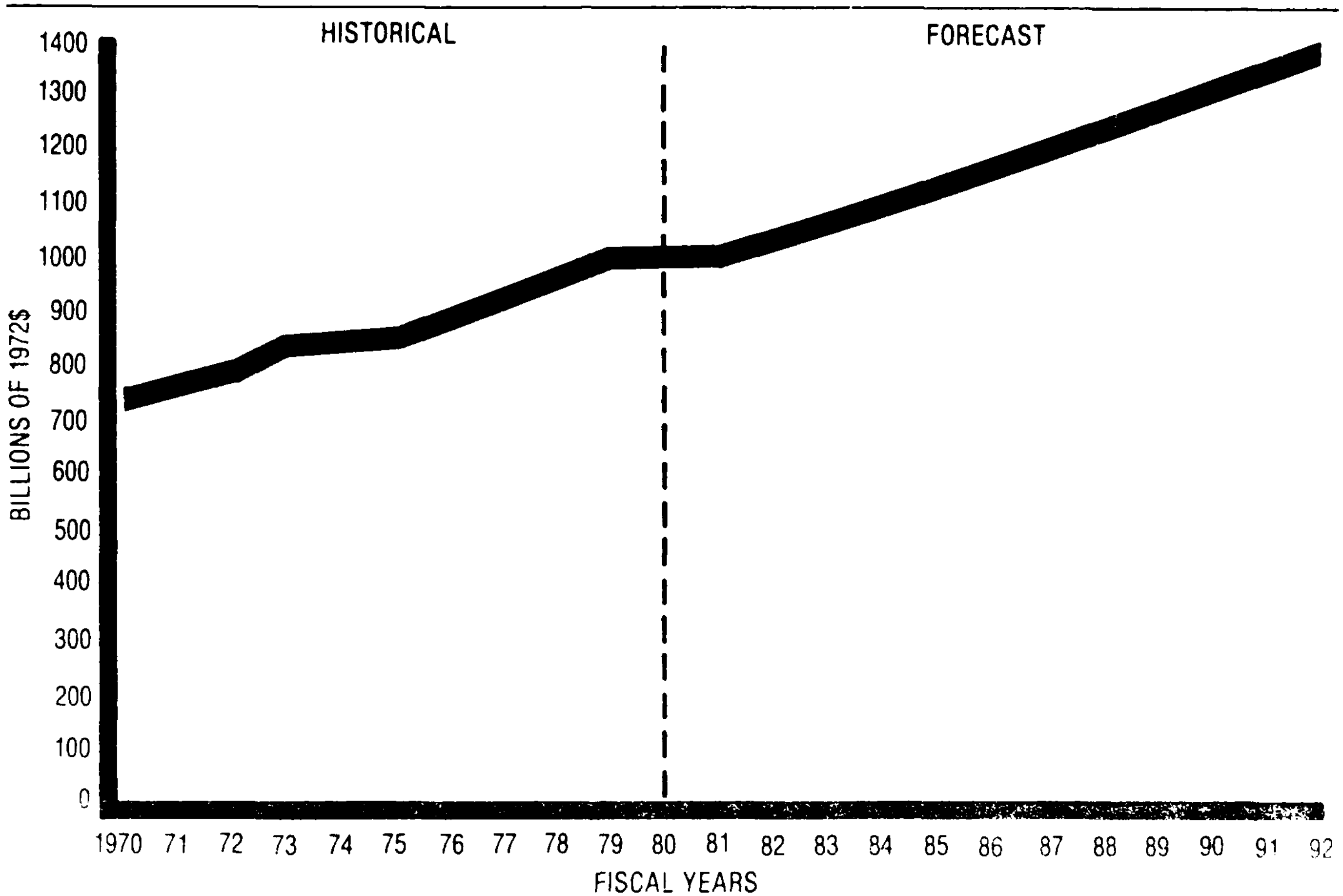
SOURCE: FEDERAL AVIATION ADMINISTRATION

FIGURE 15. CONSUMER PRICE INDEX



SOURCE: FEDERAL AVIATION ADMINISTRATION

FIGURE 16. DISPOSABLE PERSONAL INCOME



SOURCE: FEDERAL AVIATION ADMINISTRATION

will stimulate growth in the aviation industry. The economic forecast, in general, seems good.[27]

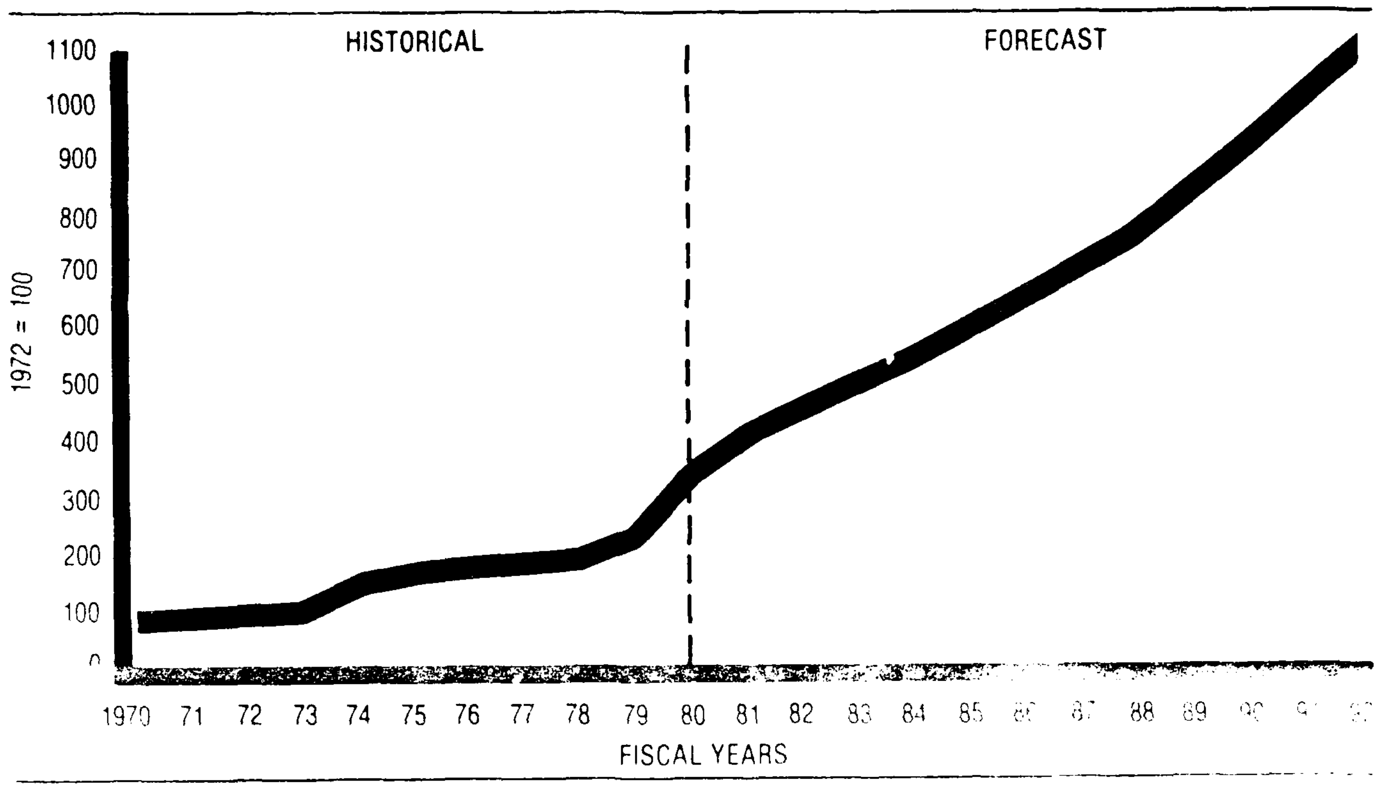
One more item used by the FAA in its aviation forecasts is an oil and gas deflator demonstrated in Figure 17. Fuel costs are expected to increase during the forecast period. For example, general aviation fuel costs are predicted to rise at an average annual rate of 10.4 percent compared to a 8.2 percent rate for the consumer price index. Fuel costs are rising faster than other consumer goods. This factor increases operating costs and tends to deflate the demand for airspace and air traffic control services.[28] Specifically, current jet fuel prices have declined slightly due to the present crude oil glut, but future demand is again supposed to exceed production. The Energy Department predicts an average annual rise in jet fuel prices of 7.3 percent in 1980 dollars from 1985 to 1990 and then a 9.3 percent annual rise from 1990 to 1995. The range of prediction for jet fuel cost in 1995 given in 1980 dollars varies between $1.51 to $2.46 per gallon. The midrange projection is slightly under $2.00 per gallon.[29]

The above variables are used to make forecasts of aviation activity for general aviation, air carriers, and commuter airlines, and also forecasts for FAA workload measures. These forecasts are used to develop some alternative scenarios which will indicate comparative results in three different future situations.

Aviation Activity Forecasts

Aviation activity forecasts project overall growth into the 1990s (see Table 6). In each case, the forecasted annual growth rate is slower than the annual rates achieved during the 1975 to 1979 time period.

FIGURE 17. OIL AND GAS DEFLATOR



SOURCE: FEDERAL AVIATION ADMINISTRATION

TABLE 5. Economic Assumptions Used In FAA Forecasts

Fiscal Year	Disposable Personal Income (billions 1972$)	Consumer Price Index (CY1967=100)	Gross National Product (billions 1972$)	Employment (Millions)	Oil & Gas Deflator (CY 1972=100)
Historical					
1970	734.2	114.7	1,076.2	78.4	97.7
1971	762.3	120.0	1,099.4	79.0	98.5
1972	793.3	124.3	1,155.2	81.1	99.7
1973	841.2	131.1	1,219.0	83.7	106.8
1974	845.1	144.0	1,222.1	85.6	138.1
1975	855.2	157.8	1,206.0	85.1	155.5
1976	883.8	168.2	1,255.3	86.8	163.1
1977	920.0	178.7	1,323.6	89.8	171.9
1978	961.8	191.8	1,384.5	93.4	180.1
1979	989.1	212.2	1,424.9	96.0	228.3
1980	997.2	241.0	1,433.1	97.6	339.0
Forecast					
1981	1,004.7	269.1	1,442.4	98.3	413.6
1982	1,031.4	294.4	1,483.3	99.7	468.1
1983	1,063.8	318.8	1,532.1	101.4	512.8
1984	1,098.1	342.7	1,581.4	103.0	556.9
1985	1,124.4	370.1	1,623.6	104.4	606.4
1986	1,158.3	400.7	1,672.7	105.9	660.8

TABLE 5. Economic Assumptions Used In FAA Forecasts (Continued)

Fiscal Year	Disposable Personal Income (billions 1972$)	Consumer Price Index (CY1967=100)	Gross National Product (billions 1972$)	Employment (Millions)	Oil & Gas Deflator (CY 1972=100)
1987	1,191.5	434.5	1,723.7	107.4	720.8
1988	1,227.0	468.2	1,775.9	108.9	785.4
1989	1,264.5	502.2	1,826.8	110.[illegible]	855.1
1990	1,303.7	538.9	1,877.7	111.[illegible]	931.2
1991	1,344.1	578.2	1,930.2	112.9	1,015.0
1992	1,384.4	620.5	1,984.2	114.2	1,106.4

SOURCE: FAA Aviation Forecasts, Fiscal Years 1981-1992

TABLE 6. Aviation Activity Forecasts
(Fiscal Years)

	Historical		Est.	Forecast			Percent Average Annual Growth				
Aviation Activity	1975	1979	1980	1981	1982	1992	75/79	79/80	80/81	81/82	80/92
Air Carrier, Domestic											
Rev. Pass. Enps. (millions)	184.9	291.7	290.5	308.9	331.8	481.1	12.1	-0.4	6.3	7.4	4.3
Rev. Pass. Miles (billions)	127.7	205.6	201.9	215.9	232.9	352.7	12.6	-1.8	6.9	7.9	4.8
Commuter Carriers											
Rev. Pass. Enps. (millions)	6.6	12.1	13.8	15.5	17.2	35.0	16.4	14.0	12.3	11.0	8.1
Rev. Pass. Miles (billions)	0.7	1.4	1.7	1.9	2.1	4.4	18.9	21.4	11.8	10.5	8.2
General Aviation											
Fleet (thousands)	161.0	198.8	208.0	218.7	228.5	315.5	5.4	4.6	5.1	4.5	3.5
Hours Flown (millions)	31.9	41.1	42.1	43.9	46.1	64.3	6.5	2.4	4.3	5.0	3.6

SOURCE: FAA Aviation Forecasts, Fiscal Years 1981-1992

Projected general aviation growth [illegible] experience, followed by commuter [illegible]

In the early 1980s, the demand [illegible] decline briefly. This is due to the [illegible] well as the air carrier industry. Also, the [illegible] caused by the controllers' strike reduced the [illegible] ments, tower operations, and the numbers of IFR aircraft [illegible]. The perturbation is expected to disappear by the [illegible] growth rates are not projected to be as dynamic as [illegible] they are expected to rise faster than the general economy,[30] which will create increased demand for airspace and traffic control [illegible]

FAA Workload Forecasts

In Table 7, FAA workload measures are forecast for aircraft and instrument operations and for IFR aircraft handled, including air taxi and military requirements. Flight services requirements are [illegible] at the bottom of the table. Except for the need of flight services, which are generally expected to increase at faster rates than in the past, most workload measures are forecast to increase at slower rates in the future. Yet again, all workload measures are forecast to increase except for the military categories, which show zero growth rates in the [illegible]

This reflects an incorrect assumption made also in the FAA terminal area forecasts that military operations would [illegible] constant after 1979.[31] The next chapters will show that [illegible] military operations should be expected. [illegible] increase slightly and so are operations in [illegible] are proposed in the Fiscal Year 19[illegible] flying hours are planned.[32]

TABLE 7. FAA Workload Forecasts
(Millions)

FAA Workload Measures	Historical 1975	Historical 1979	Est. 1980	Forecast 1981	Forecast 1982	Forecast 1992	Percent Average Annual Growth 75/79	79/80	80/81	81/82	80/92
Aircraft Operations											
Air Carrier	9.4	10.4	10.3	10.5	10.8	12.5	2.6	-1.0	1.9	2.9	1.6
Air Taxi & Commuter	2.7	4.4	4.7	5.0	5.4	9.3	13.0	6.8	6.4	8.0	5.9
General Aviation	44.2	51.7	51.1	54.5	57.5	74.1	4.0	-1.2	6.7	5.5	3.1
Military	2.7	2.5	2.5	2.5	2.5	2.5	-1.9	0.0	0.0	0.0	0.0
Total	58.9	69.0	68.6	72.5	76.2	98.4	4.0	-0.6	5.7	5.1	3.1
Instrument Operations											
Air Carrier	9.5	10.7	10.6	10.8	11.1	12.8	3.0	-0.9	1.9	2.8	1.6
Air Taxi & Commuter	1.9	3.7	4.2	4.4	4.8	9.0	18.1	13.5	4.8	9.1	6.6
General Aviation	10.7	17.9	19.6	22.6	23.3	30.5	13.7	9.5	15.3	3.1	3.8
Military	3.9	3.9	4.3	4.3	4.3	4.3	0.0	10.3	0.0	0.0	0.0
Total	26.1	36.2	38.7	42.1	43.5	56.6	8.5	6.9	8.8	3.3	3.2

TABLE 7. FAA Workload Forecasts (Continued)
(Millions)

	Historical		Est.	Forecast			Percent Average Annual Growth				
FAA Workload Measures	1975	1979	1980	1981	1982	1992	75/79	79/80	80/81	81/82	80/92
IFR Aircraft Handled											
Air Carrier	12.4	14.0	13.9	14.1	14.4	17.0	3.1	[illegible]	[illegible]	[illegible]	[illegible]
Air Taxi & Commuter	[illegible]	2.3	2.5	2.9	3.1	5.6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
General Aviation	[illegible]	8.8	[illegible]	9.7	10.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Military	4.4	4.8	4.7	4.7	4.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]											
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] FAA Aviation Forecasts, Fiscal Years 1981-1992

The impact of this erroneous assumption on ATC is particularly worrisome. As pointed out in the last chapter, ATC activities tend to change more dynamically than those of the rest of the Air Force. They react to force size changes as well as pilot retention fluctuations. Since the Korean conflict, the total pilot force has had a fairly constant decline in size; the Vietnam conflict was an exception which produced an increase in pilot requirements of about 3,000 in a 1- to 2-year period just after 1970. Unlike the smooth trends of force structure, pilot training rates have varied considerably since the Korean era from nearly 7,000 to 1,100 pilots trained annually, as seen in Figure 12. ATC was at a low ebb in 1979, which the FAA selected as the period to hold constant in its projections. In fact, pilot training rates have already nearly doubled and will more than double the 1979 numbers by the mid-1980s. This will also more than double the flying hours, operations, and services required by ATC. Again, this growth was not considered by the FAA.

The growth rates for all categories of FAA workload--for air taxi, commuter, and general aviation--exceed air carrier growth rates. In particular, the instrument operations growth rates demonstrate how the relative demand for service and airspace will be changing. The smaller aircraft are getting more sophisticated avionics systems contributing to the need for controlled airspace. Also, this reflects relatively faster growth in commuter airlines and general aviation aircraft used for business purposes. The aircraft used are more likely to compete for high or terminal airspace previously used mainly by military or commercial aircraft.

Another indicator of future increased competition for FAA services is the growing percentage of pilots who have an instrument rating. In 1970, 32 percent of licensed pilots had an instrument rating; 41 percent

had an instrument rating by the end of 1979.[33] The forecast through 1992 shows a slightly higher percentage of instrument-rated pilots.[34] Thus, more pilots will be capable of using terminal and en route IFR services, further increasing competition for this type service.

The expected rapid growth of civil aviation in the next few years is a problem the FAA has to solve. It has taken about 75 years to get 120,000 active civil aircraft in this country. An additional 100,000 airplanes should be active within 9 years.[35] That is about seven times the growth rate of the past and will nearly double the number of civil aircraft needing service in the future.

General Aviation Growth

Table 6 shows expected growth in the general aviation fleet. The fixed-wing growth trends between 1981 and 1992 help demonstrate the types of flying and future demand for airspace to be expected. The number of active turboprop and turbojet aircraft nearly doubles while the number of piston aircraft increases by about 40 percent. The number of single-engine piston aircraft makes up the preponderance of the fixed-wing fleet--about 85 percent. The forecast adds 71,000 of these aircraft from 1981 to 1992. The number of turbine-powered aircraft should nearly double between 1981 and 1992.

The forecasts of hours flown by fixed-wing, general aviation aircraft show about a 38 percent increase for piston aircraft and an 86 percent increase for turbine-powered aircraft. Figure 18 demonstrates the rapid growth expected in the demand for all categories of FAA service. The greatest requirement is shown in itinerant operations with local operations growing more slowly. The relationship between local operations and

TABLE 8. Estimated Active General Aviation Aircraft By Type Of Aircraft
(Thousands)

As of January 1	Total	Fixed Wing				Rotorcraft		Balloons Dirigibles Gliders
		Piston						
		Single Engine	Multi-Engine	Turboprop	Turbojet	Piston	Turbine	
Historical*								
1975	161.0	131.5	19.7	2.1	1.6	2.3	1.3	2.5
1976	168.0	136.6	20.3	2.5	1.7	2.5	1.6	2.8
1977	178.0	144.8	21.3	2.5	1.9	2.7	1.7	3.1
1978	184.3	149.3	21.5	2.9	2.3	2.7	2.1	3.6
1979	198.8	160.7	23.2	3.1	2.5	2.8	2.5	4.0
1980E	208.0	167.1	24.5	3.4	3.0	2.9	2.9	4.2
Forecast								
1981	218.7	175.81	25.0	3.8	3.2	3.1	3.2	4.6
1982	228.5	183.2	26.0	4.2	3.4	3.3	3.4	5.0
1983	237.1	189.4	26.9	4.6	3.7	3.4	3.7	5.4
1984	245.8	195.7	27.9	5.0	4.0	3.5	4.0	5.7
1985	254.5	202.1	28.8	5.3	4.3	3.6	4.3	6.1
1986	263.2	208.5	29.7	5.6	4.6	3.8	4.6	6.4

TABLE 8. ESTIMATED ACTIVE GENERAL AVIATION AIRCRAFT BY TYPE OF AIRCRAFT
(Thousands)

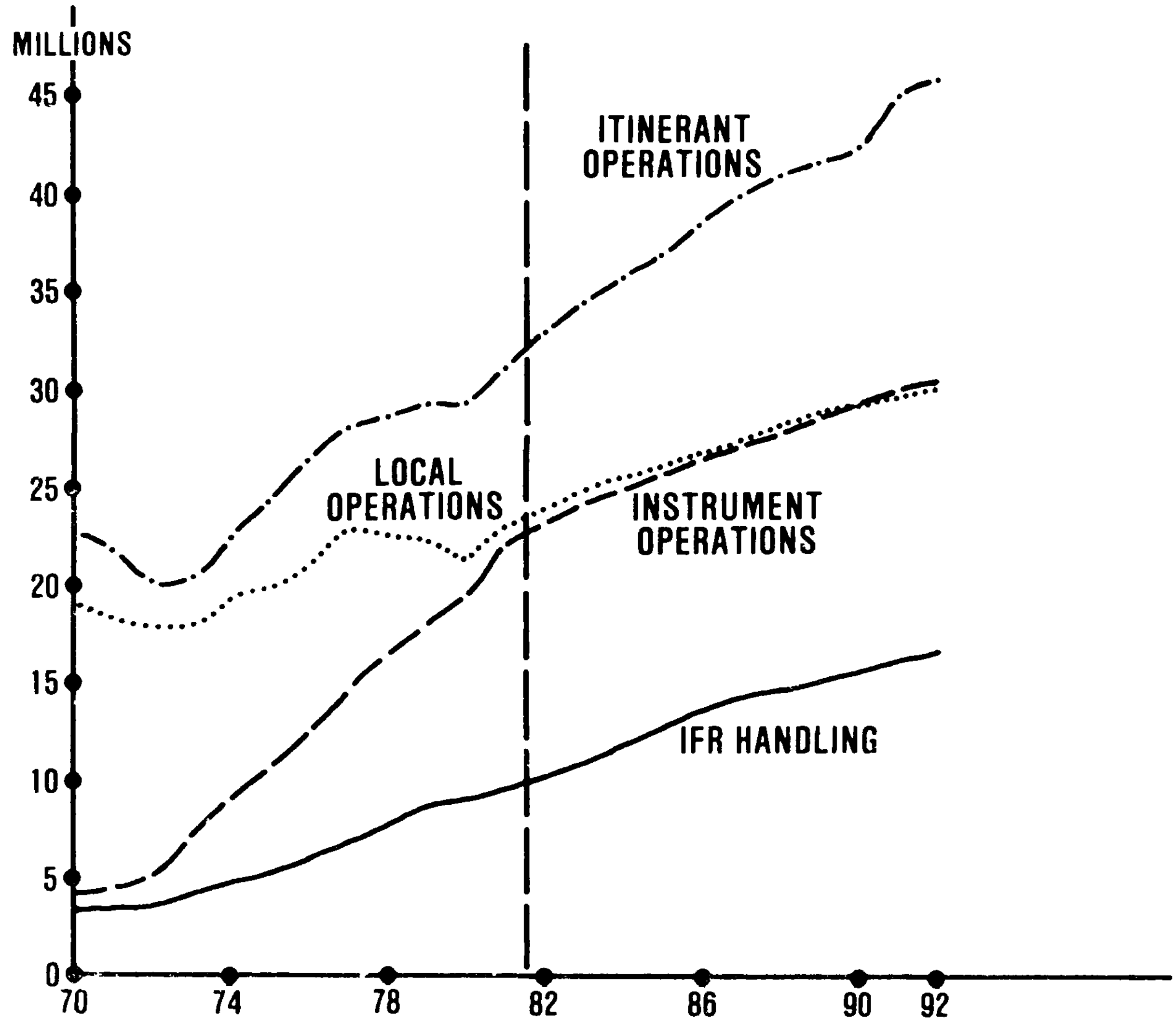
As of January 1	Total	Fixed Wing				Rotorcraft		Balloons Dirigibles Gliders
		Piston						
		Single Engine	Multi-Engine	Turboprop	Turbojet	Piston	Turbine	
Forecast (continued)								
1987	271.4	214.4	30.7	5.9	4.8	3.9	4.9	6.8
1988	280.7	221.2	31.6	6.2	5.1	4.1	5.3	7.2
1989	289.6	227.6	32.6	6.5	5.4	4.2	5.6	7.5
1990	298.1	234.0	33.5	6.8	5.7	4.3	5.9	[illegible]
1991	306.8	240.4	34.4	7.1	6.0	4.5	6.2	8[illegible]
1992	315.5	246.8	35.4	7.4	6.2	4.6	6.5	[illegible]

*SOURCE: FAA Aviation Forecasts, Fiscal Years 1981-1992

E - Estimate

Detail may not add to total because of independent rounding.

An active aircraft must have a current registration and it must have been flown during the previous calendar year.



SOURCE: Federal Aviation Administration

Figure 18. General Aviation Demand for Service

the other three factors shown reflect the trend toward a greater proportion of business flying and more sophistication in the general aviation category. The multiengine piston and jet-powered group, while only about 15 percent of the fixed-wing total, grows by 17,000 during the same period. The rapid growth of multiengine and jet-powered aircraft is indicative of the increased business use of general aviation aircraft.

Where will the greatest growth in general aviation aircraft occur? The Great Lakes region will continue to have the greatest number of general aviation aircraft, but the region is second in projected growth. (See Figure 19 for a definition of regional boundaries and Table 9 for the number of general aviation aircraft in each region. These regions have been redefined since this data was published.) The greatest growth in the number of aircraft will be in the western region, which will have the second largest number of aircraft. The Rocky Mountain region has the highest projected percent of growth (67), followed by the northwestern region (54). The northwestern quarter of the country is forecast to have the most dynamic growth in terms of percent increase. When size and amount of growth projected are compared by region, the top four always include the western, southwestern, and southern regions.

It follows then that the general aviation airspace requirements are forecast to increase in the future. There will be growth in all areas of the country with the northwestern quadrant growing at the fastest rate. The greatest numerical growth will be across the southern portion of the country. A significant part of the expected general aviation growth is in the larger, more sophisticated business-use type aircraft. This will change somewhat the balance of the general aviation needs for airspace in the future.

Figure 19 Old and New Regional Boundaries (Including of Regional Headquarters and Centers)

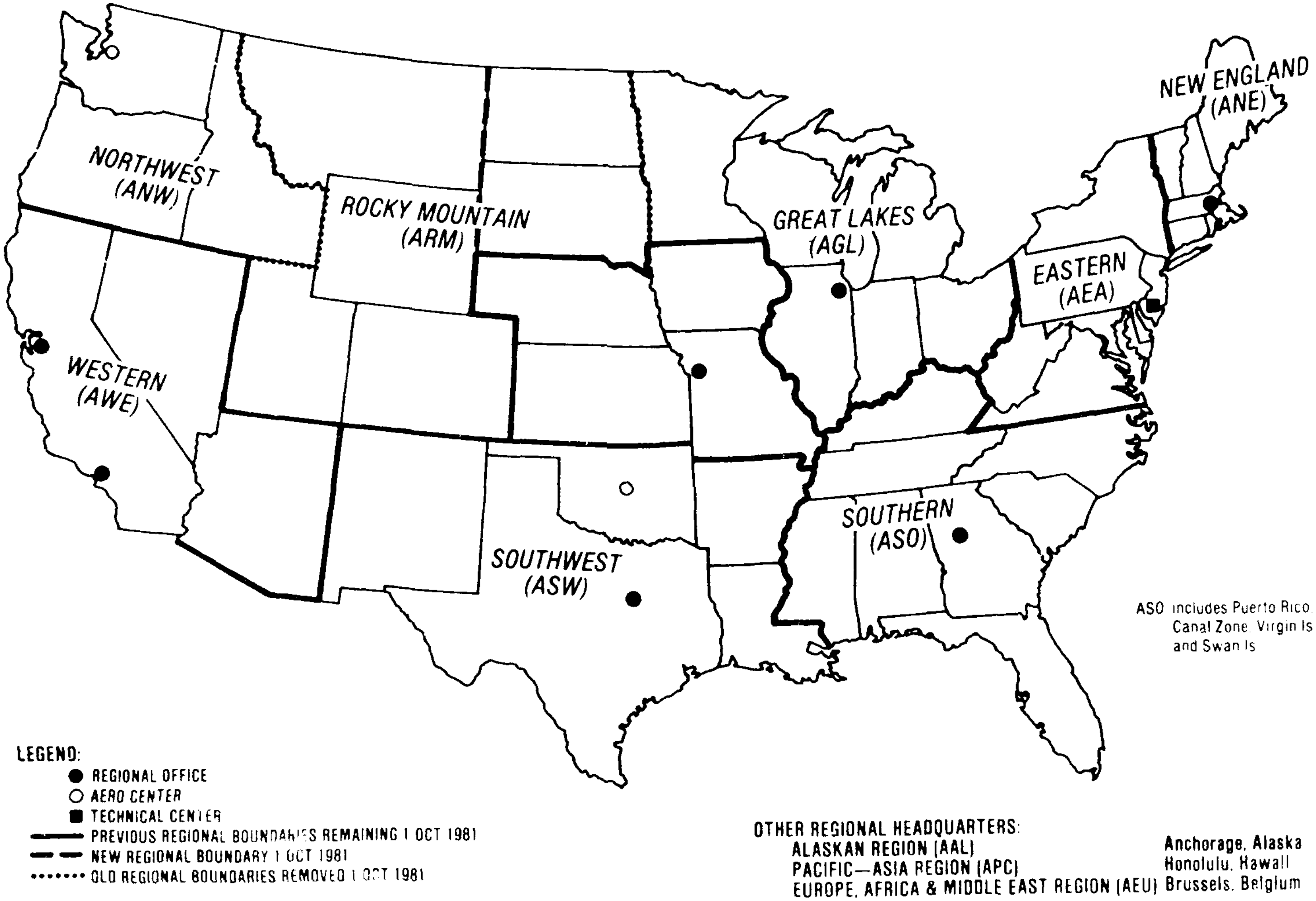


TABLE 9. Estimated Active General Aviation Aircraft By FAA Region
(Thousands)

As of January 1	Total	FAA Region										
		ANE	AEA	ASO	AGL	ACE	ASW	ARM	AWE	ANW	AAL	APC
Historical*												
1975	161.0	6.2	21.1	24.3	30.6	11.6	21.6	8.3	25.0	8.6	3.4	.3
1976	168.0	6.4	21.1	24.8	30.9	12.3	23.0	9.3	25.8	9.8	4.2	.3
1977	178.0	6.4	21.7	26.2	32.6	13.3	24.2	10.0	27.5	11.0	[illegible]	.4
1978	184.3	6.6	21.7	26.9	33.2	13.6	25.8	28.4	11.4	11.4	[illegible]	[illegible]
1979	198.8	7.5	23.7	29.5	34.6	13.7	26.7	[illegible]	30.8	[illegible]	[illegible]	[illegible]
1980E	208.0	7.9	[illegible]	30.7	35.8	14.3	27.0	[illegible]	32.3	[illegible]	[illegible]	[illegible]
Forecast												
1981	218.7	8.3	25.5	32.1	37.3	15.1	29.3	[illegible]	34.0	[illegible]	[illegible]	
1982	228.5	8.6	26.5	33.4	38.8	15.8	30.6	[illegible]	35.5	[illegible]	[illegible]	
1983	237.1	8.8	27.4	34.7	40.1	16.5	31.8	[illegible]	36.8	[illegible]	[illegible]	[illegible]
1984	245.8	9.1	28.4	35.8	41.5	17.1	32.9	[illegible]	38.1	[illegible]	[illegible]	[illegible]
1985	254.5	9.3	29.3	37.0	42.9	17.7	34.0	17.5	39.5	18.7	[illegible]	[illegible]
1986	263.2	9.5	30.1	38.1	44.3	18.2	35.2	18.7	40.7	[illegible]	[illegible]	[illegible]

TABLE 9. Estimated Active General Aviation Aircraft By FAA Region (Continued)
(Thousands)

As of January 1	Total	FAA Region ANE	AEA	ASO	AGL	ACE	ASW	ARM	AWE	ANW	AAL	APC
Forecast (continued)												
1987	271.4	9.7	30.9	39.3	45.7	18.7	36.4	19.4	41.9	20.1	8.2	1.1
1988	280.7	9.9	31.8	40.8	47.1	19.2	37.6	20.2	43.4	21.1	8.5	1.1
1989	289.4	10.1	32.5	42.0	48.5	19.7	38.7	21.0	44.9	22.0	8.8	1.2
1990	298.1	10.3	33.3	43.2	49.9	20.2	39.9	21.8	46.5	22.7	9.1	1.2
1991	306.8	10.5	34.0	44.5	51.3	20.7	41.1	22.7	48.0	23.4	9.4	1.2
1992	315.5	10.7	34.7	45.7	52.7	21.1	42.3	23.6	49.5	24.2	9.7	1.3

*SOURCE: FAA Aviation Forecasts, Fiscal Years 1981-1992

E - Estimate

Detail may not add to total because of independent rounding.

Totals include a small number of aircraft located in foreign countries. Also see Table 8 footnotes.

Airline Growth

Future air carrier requirements [illegible] and airspace are expected to expand along with the economy [illegible] 1982.[36] In addition to the economic recession, many [illegible] factors have simultaneously been affecting air carriers in the past few years. The recession has reduced business travel,[37] which normally is about half of all air travel.[38] The other half, personal travel, is either urgent or discretionary.[39] The reduction in discreti[illegible] was caused by the poor economy, as is indicated by the increase in [illegible] fare levels due largely to rising fuel prices and declining load factors in the last 2 years.[40] Inversely, the traffic growth in the first [illegible] 1982 is attributed to discount fare inducements.[41] In fact, 71 percent of all revenue passenger mileage was discount traffic in 1981--an annual high.

The Airline Deregulation Act of 1978 will continue to influence airline service and airspace requirements. Traditional relationships between the larger and smaller carriers have changed and will continue to change in the future. Route structures have changed markedly in the past few years. Many new, smaller commuter and air taxi service carriers have been started, creating intense competition in [illegible] currently weak market. Some 37 new carriers have received certification. Several mergers and acquisitions have occurred. Future airline company failures are possible. "Patterns of service, route structure, and equipment usage are changing in response to conditions in the marketplace [illegible] operating costs for air transportation services."[42]

Many major trunk and local air [illegible] leaving short-haul, low-density routes while expanding service [illegible] routes and increasing their other service. They are concentrating [illegible] higher density, longer

routes as more profitable for the large jet aircraft they use. The effect of the changes is seen in the relationship of aircraft miles scheduled, departures offered, and average stage length of the three carrier groups. Between July 1978 and July 1980, trunk airlines' share of aircraft miles scheduled decreased by 3.6 percent while local service carriers increased their share by 1.8 percent. Former intrastate carriers (now interstate) also increased their share by 0.5 percent. The trunk airlines' scheduled departures declined by 4.5 percent, and the local service carriers' share dropped 1.4 percent as interstate carriers' share of scheduled departures increased by 0.7 percent. All three types of carriers increased their average stage length: trunk carriers from 616 to 692 miles, local service carriers 213 to 275, interstate carriers 262 to 271 miles.

Data reported for the top 70 commuter carriers is included above. Alone, these carriers increased their share of scheduled miles by 1.6 percent and their share of scheduled departures 5.2 percent. The stage lengths of these carriers increased from 96 to 109 miles.[43]

These changes reflect the shifts that will continue to take place. The trend is to use aircraft of the most efficient size for each market to increase load factors and profits. This means there will be more flights of smaller aircraft to move the same number of passengers on feeder routes to traffic hubs and the trunk airlines. The effect should be an overall increase in the need for airspace and controller services.

The major airlines should also be making equipment changes in the next few years. They plan to replace their current aircraft with quieter, more efficiently powered planes that have greater seating capacity. As long as excess carrying capacity is not created, the greater efficiency should lower relative travel cost, which would increase demand for travel.

However, the larger individual aircraft passenger capacity will have the opposite effect on the demand for airspace and controller services. The net impact should be modest increases in air carrier demand for airspace and service.

Factored into air carrier growth is an increasing demand for air cargo service. The growth of air cargo traffic has not been as dramatic as passenger traffic. Only extremely perishable cargo, such as fresh fruit and flowers, was carried. With the more efficient new jets, air freight was used to fill the relatively empty belly cargo compartments. When rapid delivery of products could save warehouse inventory costs, such as some electronic components and textiles, air freight has been used. "Instead of stocking large inventories, companies will be able to avoid high interest and large warehousing requirements by shipping smaller quantities more frequently."[44] Air cargo specialists are forecasting a 3 to 5 percent growth over the next 5 years. The FAA forecasts are for an annual domestic increase of just under 5 percent through 1992.[45] All cargo carriers (8 in 1979) with about 90 airplanes[46] are, and will be, competing with passenger carrier airlines for air cargo business in the future. In addition, multi-transport cargo companies, such as Emery Worldwide and United Parcel Service, are emerging in competition for air cargo. Deregulation and intense competition will impede this sector's growth even with an upturn in the economy.[47] Yet, its continued growth will add to the total demand for airspace and controller service from all air carriers.

Figure 20 demonstrates the expected demand for FAA services from all air carriers. Steady growth is evident. Air carrier needs for instrument and itinerant operations services will remain below the levels and

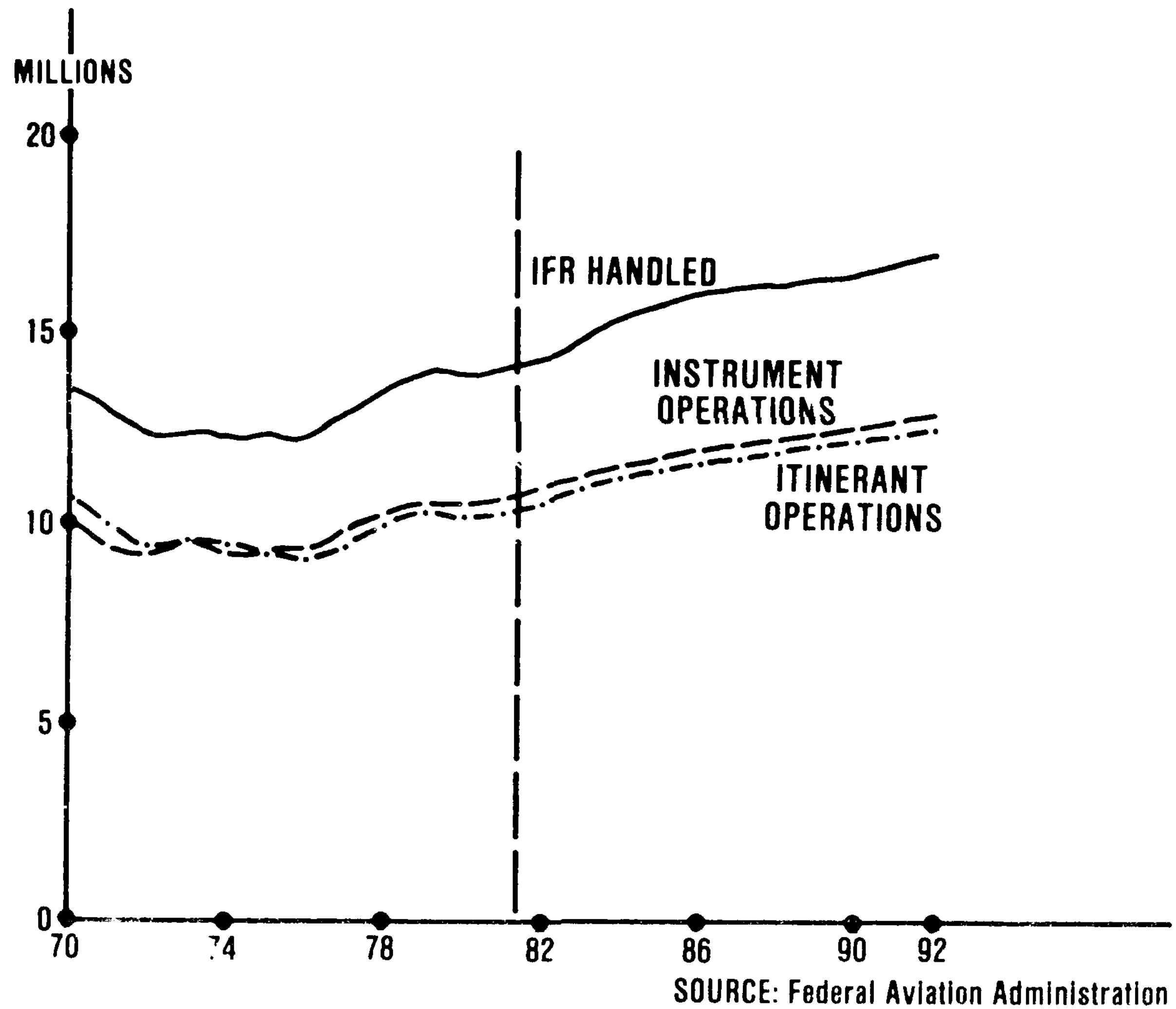


Figure 20. Air Carrier Demand for FAA Service

rates of general aviation's needs for these services from 1982 to 1992 (Figure 18). The general aviation need for [illegible] handling from air route traffic control centers approaches the need of air carriers by the later 1990s.

Commuter Airline Growth

Commuter airlines are developing an infrastructure in the environment created by the Airlines Deregulation Act. The act allows certification of aircraft with up to 56 seats (Civil Aeronautics Board action increased this to 60). Also, commuter [illegible] federal loan guarantees, and the communities they serve realize assistance under the Essential Air Service Program. Ready markets for service are being vacated by larger carriers. Rising automobile fuel costs make the commuter carriers an attractive mode of travel.[48]

The number of commuter carriers has risen quickly--about 30 have petitioned for and have been awarded certification since deregulation.[49] However, the total number is expected to decrease in the future because of competition and mergers. The relative price of fuel and the impact of new taxes on both gasoline and air travel will strongly influence the commuter industry.[50] The forecast used for this study assumes a status quo. A sure and positive factor is that the newer aircraft being produced for this market will allow for more passenger comfort than the general aviation aircraft previously used.

Overall, through the early 1990s, the demand for commuter services should have a relatively high growth rate. Initially, a recovery from the declines of 1981 and 1982 should be marked by rapid growth, followed by a strong market through the end of the forecast period. For example, commuters are expected to enplane [illegible] million passengers in 1983 in the

contiguous 48 states and Alaska. That number climbs to 29.3 million in 1993. The annual rate of increase is above 10 percent through Fiscal Year 1985 and declines gradually to 7.5 or 8.0 percent in the early 1990s. Aircraft operations increase steadily by 300,000 per year in the forecasting model used recently by the FAA.[51] This means that revenue passenger enplanements should more than double, and commuter aircraft operations should increase by over 75 percent in the 10 years between 1982 and 1992. The smaller increase in operations reflects the growth in passenger capacity expected in the commuter aircraft.

Figure 21 shows the service requirements projected for commuter and air taxi operations. The relationships are the same as for general aviation with steady growth. The greatest competition for service from commuter airlines will come in terminal areas as their requirements approach those of larger air carriers.

Alternate Scenarios

As pointed out earlier, forecasts of FAA workloads into the distant future will vary greatly, with very small changes to growth rate assumptions. This is true for all the population and economic growth factors used that, in turn, produce growth rates in the workloads. Hypothetically, given a GNP of $1,500 billion (in 1972 dollars)--about what we have today--and projecting 10 years to 1992, the difference between a 2.5 percent and a 3.5 percent annual growth rate would be over $195 billion. This amount is nearly 10 percent of the projected GNP. Both of the annual growth rate examples are well within the range of reasonable assumptions.

The FAA's workload forecasts include alternative scenarios which range from stagflation to economic expansion. Its forecasts for Fiscal

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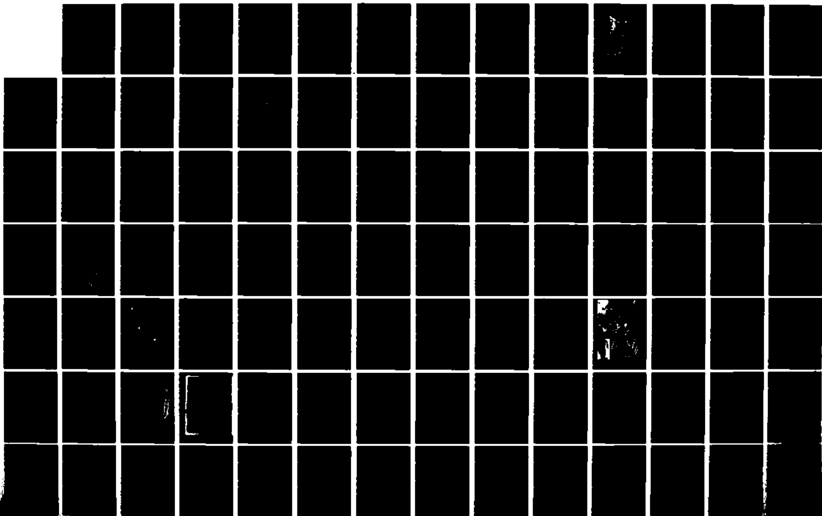
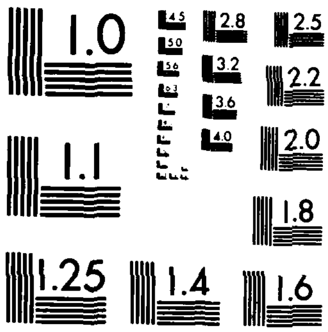
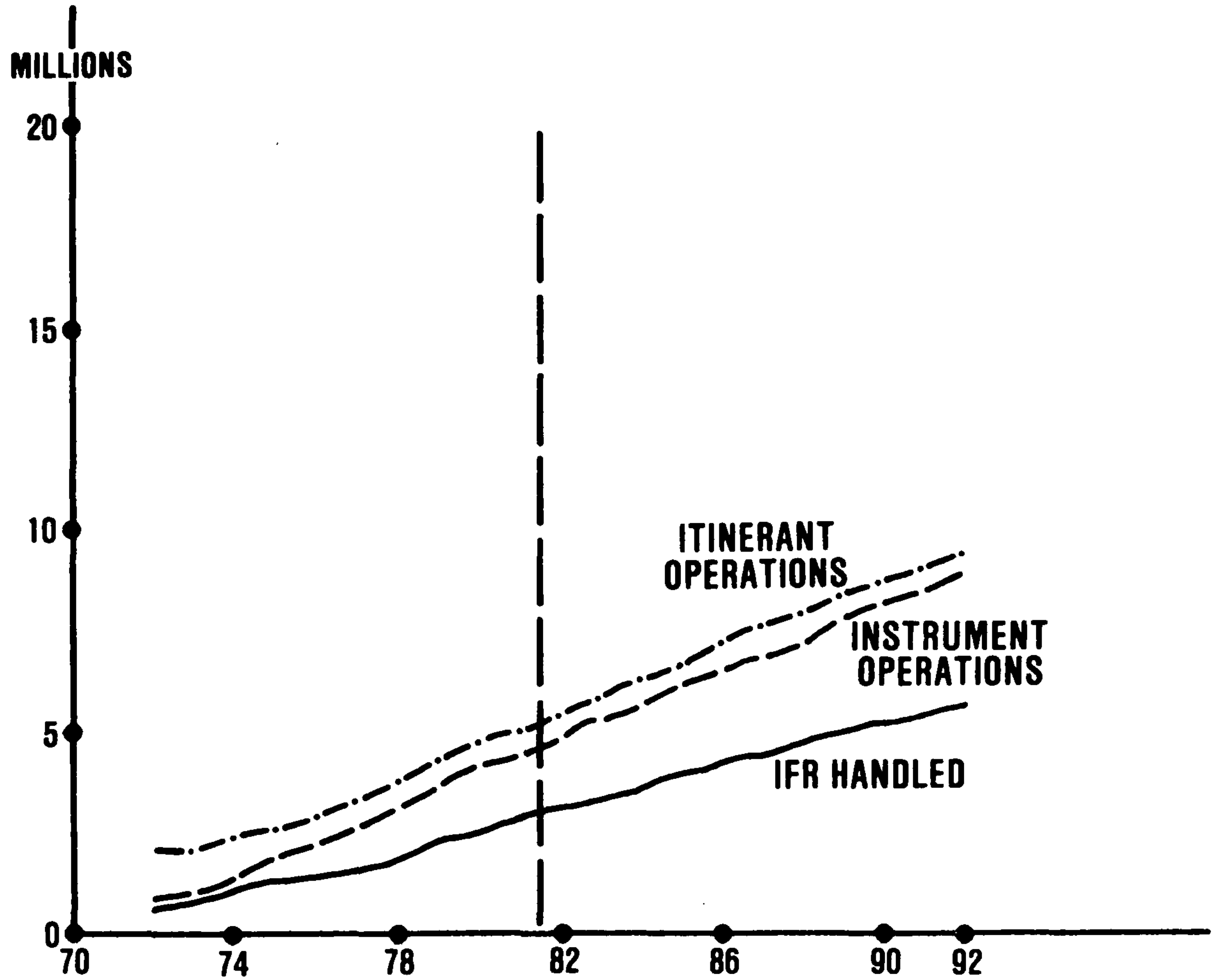




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



SOURCE: Federal Aviation Administration

Figure 21. Commuter and Air Taxi Demand for FAA Service

Years 1981 to 1991 include an energy conservation scenario. Its next forecast publication for Fiscal Years 1982 to 1993 uses the President's economic recovery scenario as a baseline and includes the Wharton Econometric model for comparison. This study relies on the slightly more conservative Wharton model (and earlier FAA forecasts) since full passage of the President's budget and economic plans seems doubtful. In addition, at the recent House of Representatives hearings on economic policy and productivity, there was general agreement among the representatives of the three major econometric forecasting models in America (Wharton Econometric Forecasting Associates, Chase Econometrics, and Data Resources, Inc.) that the President's forecasts were somewhat overly optimistic. However, they all agree the economy is strong, and a recovery is in process.[52]

The economic expansion scenario provides for rapid expansion of the national economy, which generates strong growth in all sectors of civil aviation. The stagflation scenario assumes a prolonged worldwide recession and a very slow economic growth which generally reduces the demand for air travel. The President's plan, energy conservation scenario, and the Wharton baseline all fall between the extremes of the economic expansion and stagflation scenarios.

Table 10 includes a comparison of the FAA workload forecasts through 1992. The most recent measures for Fiscal Years 1980 and 1981 can be compared to the 1992 forecasts for all scenarios. Since 1981 data were influenced by the economic recession and the NAS capacity limits were reduced due to the air traffic controllers' strike, both 1980 and 1981 data are shown. For all scenarios, except stagflation, FAA workload growth is predicted. The smallest total growth in each aggregate measure exceeds 25 percent growth compared to the higher 1980 measured baseline. The economic

TABLE 10. Comparison Of Alternative Scenario Forecasts
FAA Workload
FY 1992

FAA Workload Measure	Measured Baselines 1980	Measured Baselines 1981*	Economic Expansion	Baseline	Estimated President's Economic Recovery*	Energy Conservation	Stagflation
Tower Operations (millions)							
Total	66.2	61.6	116.8	98.4	106.2	83.5	62.1
Itinerant	44.3	42.0	81.7	66.9	69.3	60.6	48.0
Air Carrier	10.1	9.5	16.1	12.5	11.4	10.4	9.1
Air Taxi and Commuter	4.6	4.9	11.9	9.3	8.5	7.8	6.8
General Aviation	28.3	26.4	52.5	43.9	48.2	41.2	30.9
Military	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Local	21.9	19.5	35.1	31.5	36.9	22.9	14.1
General Aviation	20.6	18.2	33.8	30.2	35.6	21.6	12.8
Military	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Instrument Operations (millions)							
Total	38.2	37.2	79.5	56.6	53.8	59.3	45.4
Air Carrier	10.6	10.2	16.4	12.8	12.0	10.7	9.4
Air Taxi and Commuter	4.1	4.6	11.6	9.0	8.5	7.5	6.5
General Aviation	19.3	18.5	47.2	30.5	29.4	36.8	25.3
Military	4.1	3.9	4.3	4.3	3.9	4.3	4.3

TABLE 10. Comparison Of Alternative Scenario Forecasts (Continued)
FAA Workload
FY 1992

FAA Workload Measure	Measured Baselines 1980	1981*	Economic Expansion	Baseline	Estimated President's Economic Recovery*	Energy Conservation	Stagflation
IFR Aircraft Handled (millions)							
Total Handled	30.1	29.3	58.8	44.0	41.8	42.0	33.5
Air Carrier Handled	13.9	12.9	23.4	17.0	15.8	16.2	12.5
Air Taxi Handled	2.6	2.9	7.7	5.6	5.2	5.3	4.1
General Aviation Handled	8.9	8.9	23.0	16.7	16.2	15.8	12.2
Military Handled	4.7	4.7	4.7	4.7	4.6	4.7	4.7
Flight Services (millions)							
Total	64.3	62.6	120.4	103.4	101.8	99.9	76.8
Pilot Briefs	18.3	17.7	35.1	30.2	31.0	29.2	22.4
Flight Plans Originated	9.0	8.8	19.3	16.5	14.9	16.0	12.3
Aircraft Contacted	9.6	9.6	11.6	10.0	10.0	9.5	7.4

*SOURCE: FAA Aviation Forecasts, Fiscal Years 1982-1993

expansion aggregate measure grows by at least 75 percent. When the stagflation scenario is compared to 1980 and 1981, the total of each workload measure grows with the exception of the 1980 tower operations. When the 17 individual categories in stagflation are compared to 1980 and 1981, 5 show declines in FAA workload. These categories represent air carrier requirements, local general aviation requirements, and flight services represented by the number of aircraft contacted.

Civil Aviation Summary

What then is the overall impact on competition for airspace and FAA service from civil aviation based on the primary forecasts? All segments of civil aviation are growing but some faster than others. Each segment tends to operate in a particular route and altitude area. For example, commuter airlines fly shorter routes at lower altitudes than trunk airlines. The commuter rate of expansion is forecasted to be much more rapid than trunk airlines, but the trunk airlines will still have a greater number of instrument operations than the commuters through 1993.[53] General aviation will become more sophisticated as business use expands, and expansion of service needs into an increasing altitude structure is expected. The relationships are complex. Also given the growth rates for civil aviation, the question of where the growth is most likely to occur becomes important. Population growth and movement factors will indicate where the areas of airspace demands are likely to move.

Where the Requirements Will Be

Demographic trends are important when forecasting both general aviation and commercial air traffic. When forecasting general aviation activity, Frank R. Wilson and Harold M. Kohn write, "Despite the fact that

movements of aircraft are being forecast, it must be remembered that, in essence, it is movements of people that should be forecast."[54] When developing a model for forecasting aviation activity at Logan International Airport near Boston, Massachusetts, one study states:

> Many explanatory variables were considered for inclusion; the most basic of these is the population of the Boston area [where] it was found that population, income, and fare levels prove to be the primary determinants of the volume of air travel.[55]

Hence, this study will review the forecast of demographic trends to help show where the growth in civil airspace needs will be.

Demographic Trends

There are three basic types of change within the US population to be discussed in this study: growth, migration, and shifts in age distributions. Overall, population growth is forecast through the year 2000, according to the census bureau.[56] This positive growth factor is significant when studying demand for airspace from the civil sector. The projections are based on average annual growth rates of slightly below 1 percent. The growth rates depend, in turn, on birthrates, which tend to change cyclically. Between 1957 and 1978, birthrates have gone from 3.7 to 1.8 births per woman.[57] Dr. Ronald D. Lee, a University of Michigan economist and demographer, explains that his forecasts of future birthrates are

> based on a strong cycle of economic and population trends which can be traced back to the Depression era. . . . Today's children will comprise a relatively small age group when they become young adults during the 1980s and 1990s. As a result, their job and income prospects will be improved, and they will choose to have larger families.[58]

The birthrate that would sustain population size is about 2.1 births per woman. With the current relatively low population growth rates, migration becomes a significant factor in determining which areas will have the

greatest population growth, as confirmed during briefings to the House of Representatives: "Migration will be the key factor in the 1980s, particularly for local area population change."[59]

Historic regional growth trends have changed, influenced by migration. In the 1950s, regional growth was evenly shared in total numbers except for the Northeast, which added about 2 million fewer people than other regions. The growth rate in the West was fastest. In the 1960s, the shift in the country's population center (to the South and West) became apparent. While all areas grew, the South was the only region to experience a greater absolute growth in the 1960s than the 1970s.[60]

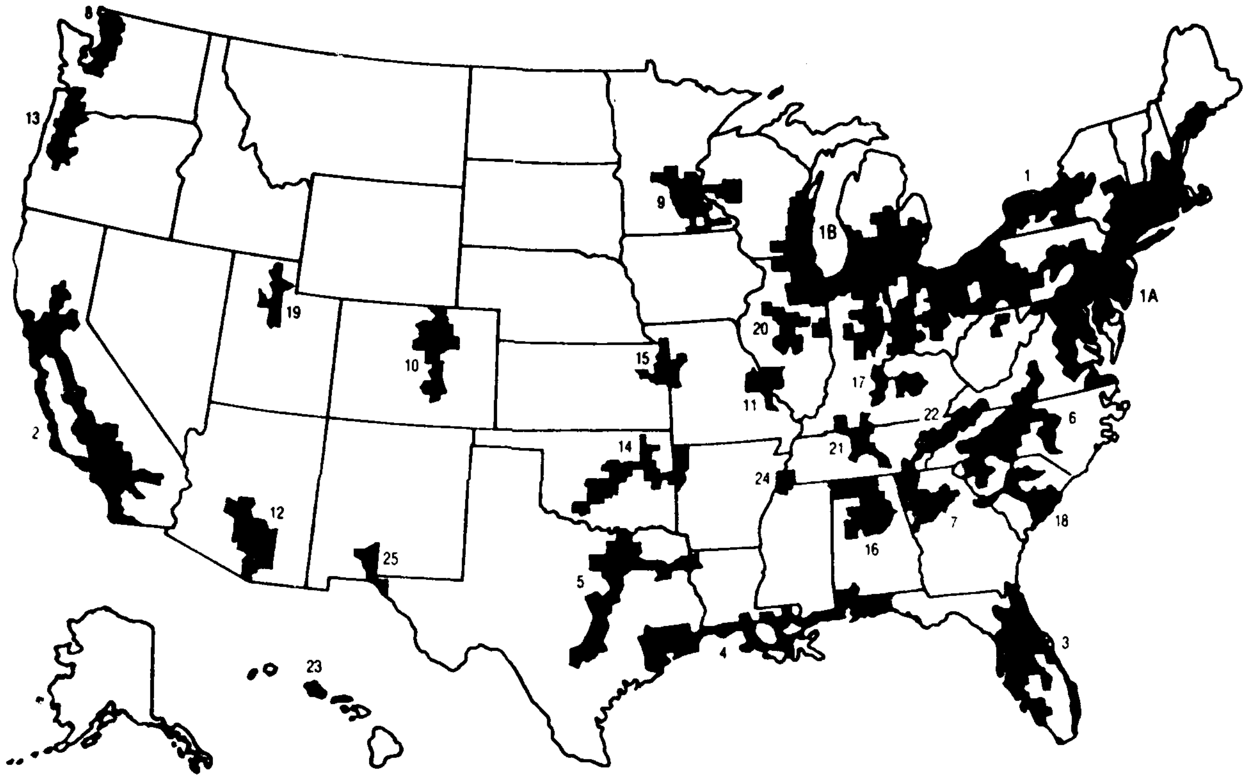
Traditionally, the net flow of population has been from rural areas, as farming has become less labor intensive, to urban areas with the expanding industrial base. This trend has reversed. More recently, people have been moving away from cities to suburbs, creating large urban regions. The Mountain States and the West have very high growth rates. Florida and Arizona are experiencing a population boom. These regional population shifts to the Sun Belt have energy-savings advantages but have put pressure on western water supplies. Because of the regional advantages of living in the South and West, this shift in the country's population center is expected to continue through the rest of the century.[61] Migration, then, is causing greater population growth in the southern and western parts of the country. Population movement away from cities is concentrating in urban regions.[62]

The reasons people migrate are changing. Each year about 17 percent of the population moves, but only 5 to 10 percent of those are forced to move. Most choose to move locally for quality-of-life factors--better housing, neighborhoods with less crime, better schools, and availability of

recreation facilities. Longer moves are motivated by better employment opportunity and higher wage rates. "Industries have moved to smaller cities, particularly in the south and in the west."[63] Greater numbers of older Americans are showing a preference for Sun Belt areas as well as moving to be near family members who have migrated to the South and West for the previous reasons.[64]

The migrations are to urban regions. Over 70 percent of the population lives in metropolitan areas.[65] These areas are blending into the urban regions or zones of continuous metropolitan areas. Urban regions are mosaics of environments ranging from rural to cosmopolitan. The largest example runs along the Atlantic Coast from Maine to Virginia and westward past Chicago. It is estimated that by the year 2000, urban regions will occupy one-sixth of the US land area and will contain five-sixths of our nation's people.[66] Figure 22 is a projection based on recent trends and a conservative growth rate of urban regions in the year 2000. These regions will generate a great amount of the civil demand for airspace in the future. The movement of civil traffic will be mostly within and between these regions. Figure 23 shows current FAA hubs and provides an interesting comparison to the urban regions.

Earlier, the impact of population age distributions as they affect fertility rates was mentioned. In a study of air travel in the Boston area, the age mix of the population proved insignificant in determining demand for air travel.[67] Yet, the movement patterns of different age groups are interesting with respect to their impact on civil airspace requirements. The population age group most apt to make long-distance moves is age 20 to 24, which means the projected older population would be slightly less mobile.[68] This younger group will soon enter the heart of

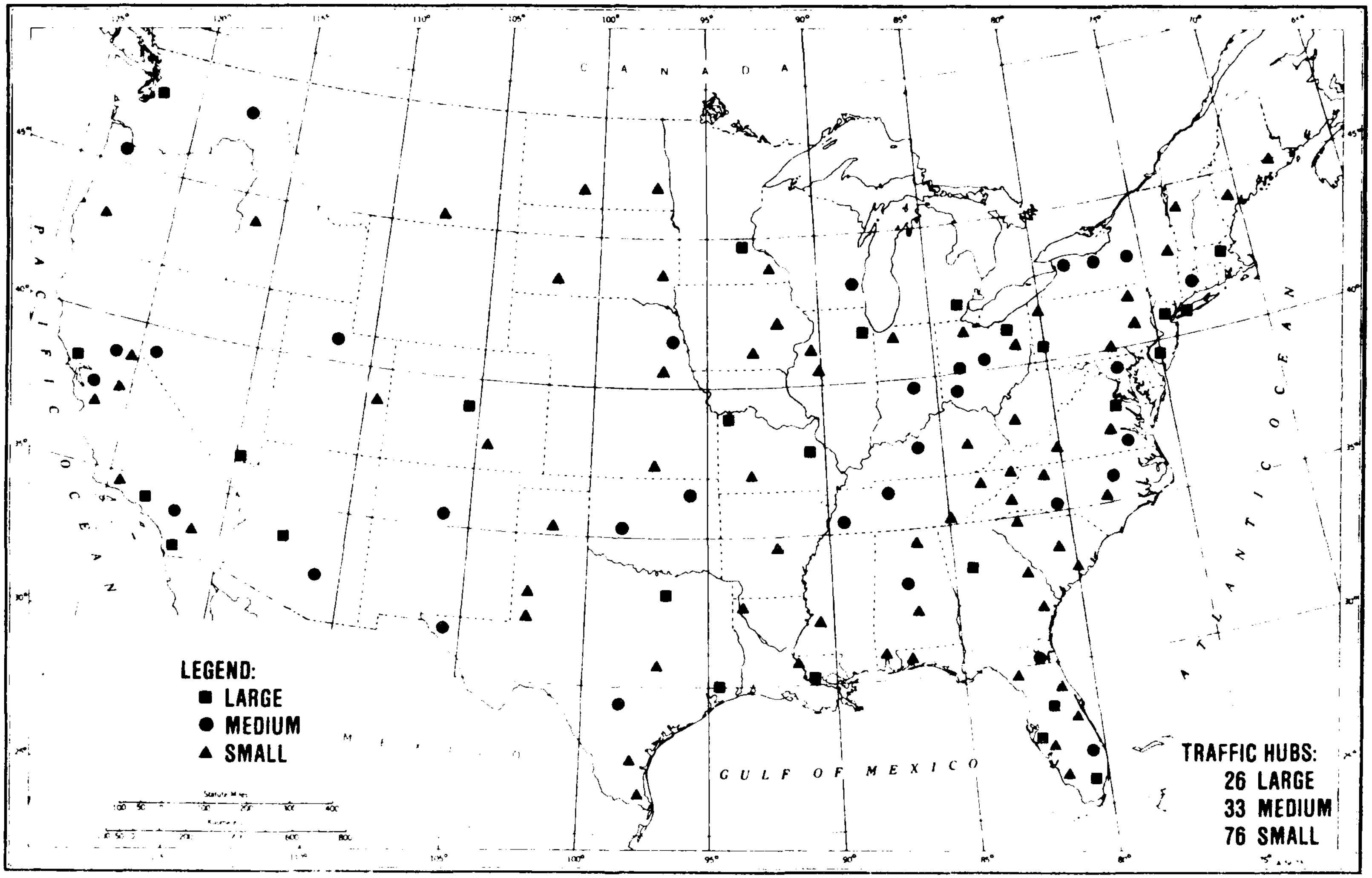


1 Metropolitan Belt
 1 a Atlantic Seabord
 1 b Lower Great Lakes
2 California Region
3 Florida Peninsula
4 Gulf Coast
5 East Central Texas—Red River
6 Southern Piedmont
7 North Georgia—South East Tennessee
8 Puget Sound
9 Twin Cities Region
10 Colorado Piedmont
11 Saint Louis
12 Metropolitan Arizona
13. Willamette Valley
14 Central Oklahoma—Arkansas Valley
15 Missouri—Kaw Valley
16 North Alabama
17 Blue Grass
18 Southern Coastal Plain
19 Salt Lake Valley
20 Central Illinois
21 Nashville Region
22 East Tennessee
23 Oahu Island
24 Memphis
25 El Paso Ciudad Juarez

Based on two-child family projection.

Source Jerome P Pickard, "U S Metropolitan Growth and Expansion 1970-2000, with Population Projections" (prepared for the Commission, 1972)

Figure 22. Urban Regions: Year 2000



SOURCE: FAA Statistical Handbook of Aviation, CY 1979

Figure 23. Current FAA Hubs

the work force, which is 25 to 64 years old. The shifts in population can be seen in Table 11. In 1975, the Northeast and Midwest combined had a greater population than the sum of the South and West. The reverse is projected to be true by the year 2000. In 1980, there were about equal work forces; but by 2000, the work force in the South and West will be larger by about 9 million, or 14 percent. The work forces of the two sectors were about equal--near 52.5 million apiece in 1980. The projections show the combined work force of the Northeast and Midwest to be about 62.5 million in the year 2000; the South and West will climb to over 71.0 million.[69]

These population growth and movement trends show why civil traffic forecasts are increasing and where the increases tend to be. The center of private pleasure flying--at lower altitudes and requiring less IFR service--will be moving south and west. The business portion of general aviation--medium altitudes and requiring moderate IFR service--will tend to increase with the dispersion of business centers in the southern region of the country. Commercial aviation--which operates en route at higher altitudes and uses all IFR service--will expand between the major urban centers, and the commercial aviation route structure will tend to move south.

IRS Confirmation

Table 12 gives economic and demographic data and statistics summarized by the Internal Revenue Service (IRS). It confirms and expands somewhat the previous demographic and economic data. The information in the table is given by IRS region in this study, but it is also available by district in each region and by service center area for the most part.[70] The land area of the western and southwestern regions make up more than half of the country's land area. (Hawaii and Alaska are included in the western region.)

TABLE 11. Population Comparison

	Population 1975	Population 1980	Population 2000	Work Force % 25-64 1980	Work Force % 25-64 2000
Northeast					
Maine	1.1	1.1	1.3	.465	.511
New Hampshire	.8	.9	1.1	.477	.525
Vermont	.5	.5	.6	.466	.519
Massachusetts	5.8	6.0	6.8	.480	.526
Rhode Island	.9	1.0	1.1	.476	.511
Connecticut	3.1	3.2	3.7	.495	.529
New York	18.1	18.1	18.8	.491	.523
New Jersey	7.3	7.6	9.0	.494	.524
Pennsylvania	11.9	11.9	12.5	.489	.521
	49.5	50.3	54.9	24.6	28.7
Midwest					
Ohio	10.7	10.9	12.0	.478	.518
Indiana	5.3	5.4	6.1	.472	.516
Illinois	11.2	11.4	12.5	.476	.517
Michigan	9.1	9.4	11.0	.474	.522
Wisconsin	4.6	4.7	5.5	.465	.520
Minnesota	3.9	4.0	4.6	.463	.523
Iowa	2.9	2.9	3.1	.465	.517
Missouri	4.8	4.9	5.5	.467	.517
North Dakota	.6	.6	.6	.446	.490
South Dakota	.7	.7	.7	.444	.488
Nebraska	1.5	1.6	1.8	.458	.508
Kansas	2.3	2.3	2.5	.468	.512
	57.6	58.8	65.9	27.7	34.1

TABLE 11. Population Comparison (Continued)

	Population			Work Force % 25-64	
	1975	1980	2000	1980	2000
South					
Delaware	.6	.6	.7	.482	.523
Maryland	4.1	4.4	5.6	.494	.541
District of Columbia	.7	.7	.7	.487	.539
Virginia	5.0	5.3	6.4	.485	.528
West Virginia	1.8	1.8	1.9	.483	.521
North Carolina	5.4	5.7	6.8	.480	.525
South Carolina	2.8	3.0	3.6	.466	.520
Georgia	4.9	5.3	6.6	.471	.526
Florida	8.3	9.3	12.9	.459	.495
Kentucky	3.4	3.5	4.0	.467	.517
Tennessee	4.2	4.3	5.1	.481	.527
Alabama	3.6	3.7	4.1	.465	.517
Mississippi	2.3	2.4	2.7	.433	.517
Arkansas	2.1	2.2	2.5	.459	.514
Louisiana	3.8	3.9	4.5	.452	.510
Oklahoma	2.7	2.8	3.3	.471	.515
Texas	12.2	13.1	16.7	.465	.511
	67.9	72.0	88.1	33.8	45.5

TABLE 11. Population Comparison (Continued)

	Population 1975	Population 1980	Population 2000	Work Force % 25-64 1980	Work Force % 25-64 2000
West					
Montana	.7	.8	.9	.468	.512
Idaho	.8	.9	1.1	.458	.505
Wyoming	.4	.4	.5	.479	.520
Colorado	2.5	2.8	3.6	.481	.528
New Mexico	1.1	1.2	1.4	.451	.494
Arizona	2.2	2.5	3.5	.456	.494
Utah	1.2	1.3	1.6	.422	.469
Nevada	.6	.6	.9	.497	.529
Washington	3.6	3.8	4.8	.482	.524
Oregon	2.3	2.4	3.1	.485	.527
California	21.2	22.5	28.1	.491	.523
Alaska	-	-	-	-	-
Hawaii	-	-	-	-	-
	36.6	39.2	49.5	18.9	25.7

	Area Population 1975	Area Population 1980	Area Population 2000	Area Work Force 1980	Area Work Force 2000
Northeast & Midwest	107.1	109.1	120.8	52.3	62.8
South & West	104.5	111.2	137.6	52.7	71.2

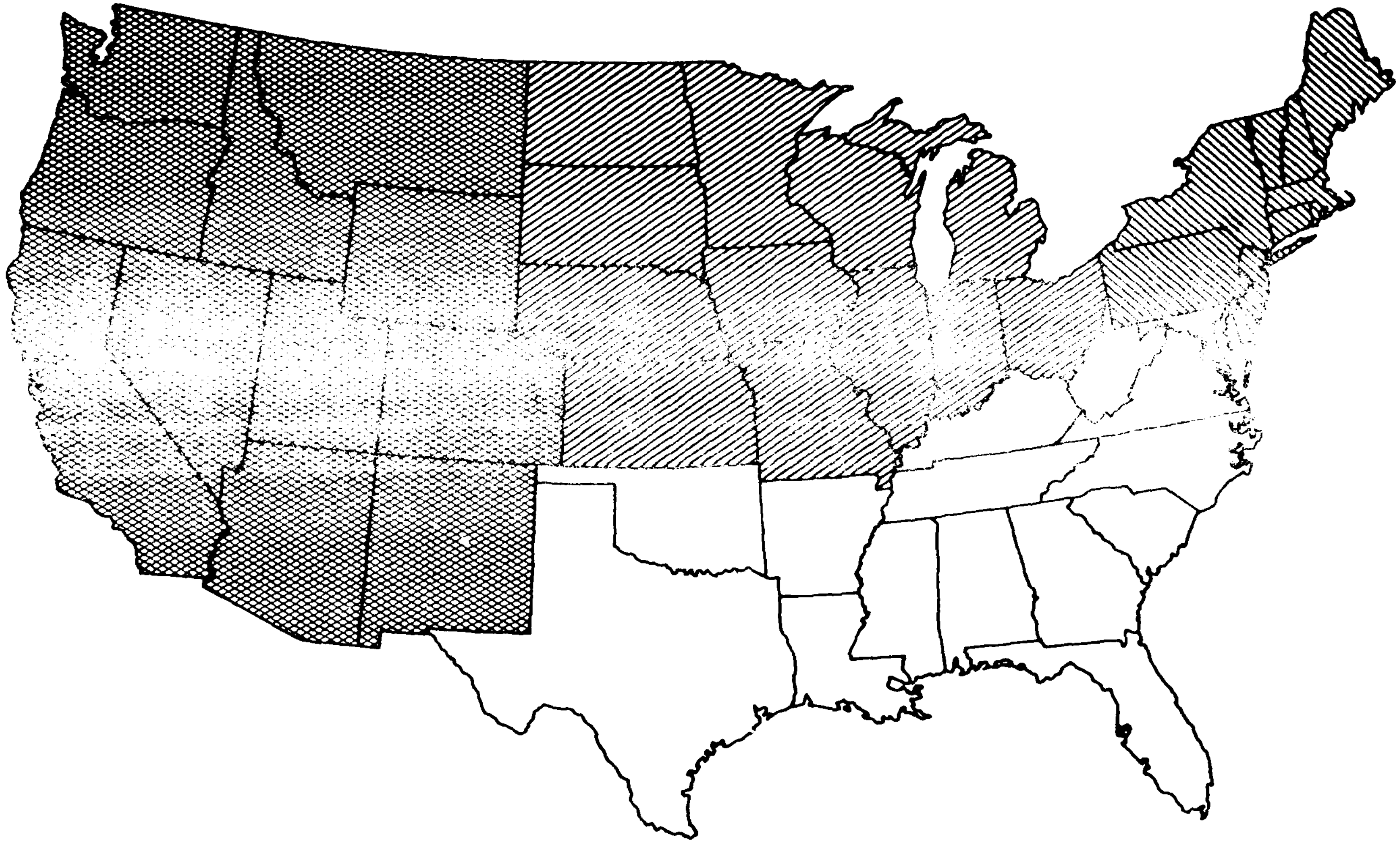


Figure 24. Population Region Depiction

TABLE 12. IRS Statistics By Region

Item		US Total	North Atlantic	Mid-Atlantic	Southeast	Central	Midwest	Southwest	West
Land Area (sq mi)		3,540,023	110,782	104,201	330,518	197,609	536,148	831,959	1,428,806
% Total		100	3.1	2.9	9.3	5.6	15.1	23.5	40.4
Resident	1965	193,457	29,063	27,702	27,130	28,406	28,538	23,743	28,875
Population(000)	1979	220,099	29,939	29,646	33,093	30,743	30,698	29,302	36,678
	1990	243,375	30,092	30,901	38,490*	32,666	32,586	34,692*	43,948*
Population	1979	11.2	12.0	11.2	12.4	10.5	11.8	10.3	10.2
Density	1990	12.5	13.3*	13.2*	14.8*	11.4	12.6*	11.0	11.3
Population Annual	1965-79	.9	0.2	0.5	1.4*	0.6	0.5	1.5*	1.7
Growth Rate	1979-90	.9	0.0	0.4	1.4	0.6	0.5	1.5	1.7
Employment Personal Income	1979	5,331	5,500*	5,513*	4,611	5,305	5,454*	5,099	5,798*
Rate (per cap $72)	1990	6,378	6,397*	6,500*	5,663	6,458*	6,571*	6,456*	6,728*
Unemployment Rate	Jul 80	7.9	7.4*	7.9*	8.3	11.3	7.7*	5.8*	7.3*
Corporate Return	1966	1,528.5	397.6	222.7	172.0	170.7	215.7	149.0	198.3
	1979	2,591.0	483.5	342.6	364.8	288.1	357.8	314.0	432.5
	1990	3,781.2	607.2	467.2	592.3	425.0	515.3	506.7	644.7
Annual Growth	1966-79	4.1	1.5	3.4	6.0	4.1	4.0	5.9	6.2
Rate	1979-90	3.5	2.1	2.9	4.5	3.6	3.4	4.4	3.7
Share Nations	1966	100	26.0	14.6	11.3	11.2	14.1	9.7	13.0
Corporate	1979	100	18.7	13.2	14.1	11.1	13.8	12.1	16.7
Returns	1990	100	16.1	12.4	15.7	11.2	13.6	13.4	17.1

*Highlights significant data

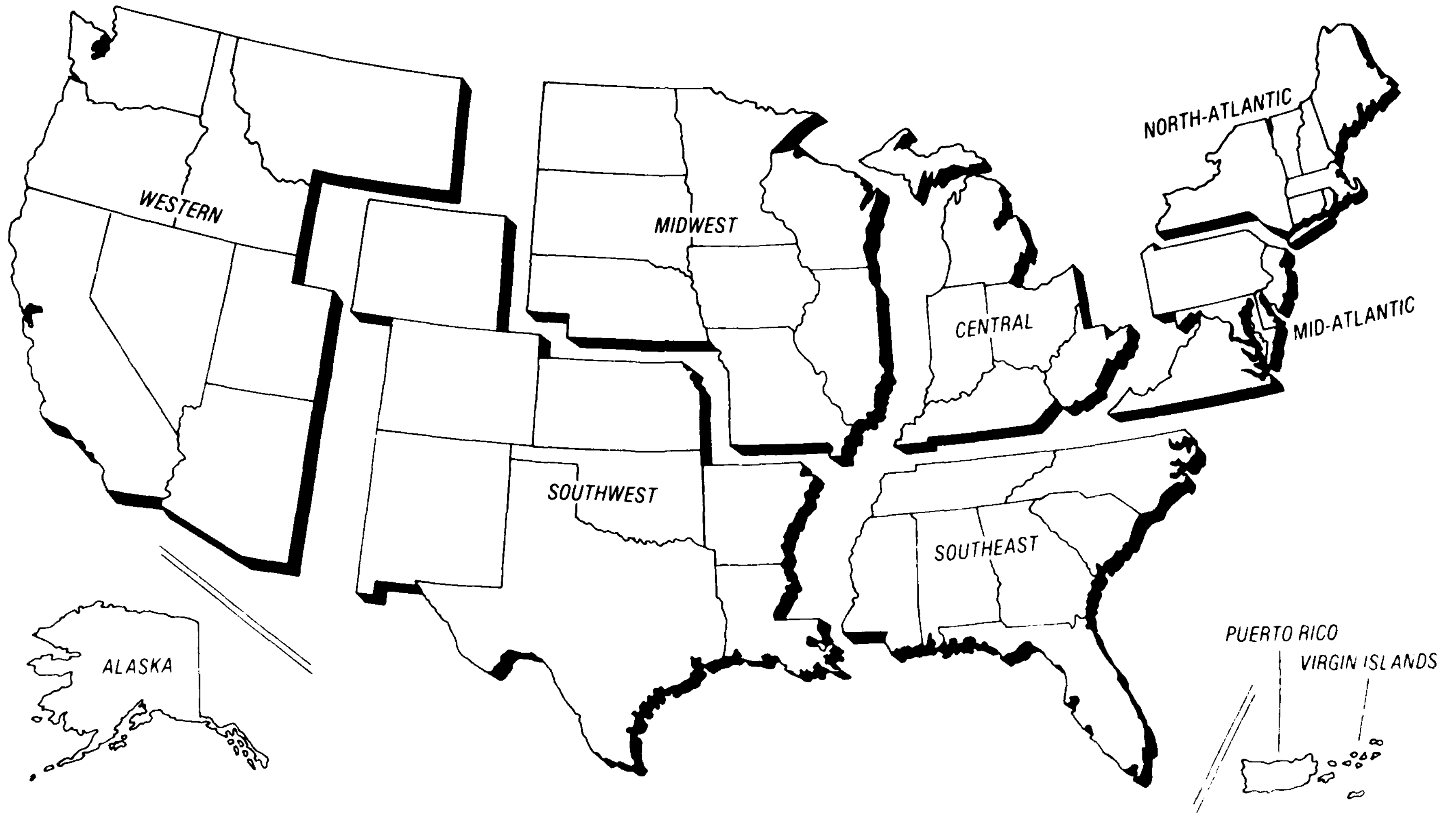


Figure 25. IRS Region Depiction

This data projects the population of all regions to grow, with the western, southwestern, and southeastern regions projected to grow at faster than total US rate. Population density is, and will continue to be, greatest along the east coast and into the Midwest. The data confirms that the population center is moving from the Northeast to the Southwest; but still population is, and will continue to be, most dense in the northeastern region of the country. The population distribution indicates the greatest competition for airspace in the Northeast, with expanding competition in the South and West.

Employment data is given in terms of real personal income in 1972 dollars and the 1980 unemployment rate. Regions with a stronger economy should tend to generate relatively greater demand for air travel and airspace competition. Compared to the national average, the southeastern regions remains depressed. The northern, mid-Atlantic, midwestern, and western regions remain strong. The central and southwestern regions are projected to show personal income levels rising from below in 1979, to above the national average by 1990. The unemployment rates by region as of July 1980 show the lowest level to be in the southwestern region, with most other regions near the national average. The exception is the central region, with an 11.3 percent unemployment rate.

Corporate tax returns are given to show relative movement of large business. The movement of business would indicate where people would migrate and vice versa. This indicates demand trends in an area for commercial air travel, private flying, and increased business flying. The regions are ranked 1 to 7 in each of the three years given by the number of returns and the number expected. The North Atlantic region is first but begins to slip by the 1990 projection. The mid-Atlantic region

dropped in 1979 and continues down in the projection. The central and mid-western regions do not improve in the projection after slipping a notch lower between 1966 and 1979. The southeastern region improves to third by 1979 and is projected to remain there. The southwestern region shows a steady climb in ranking by the number of corporate returns filed. The western region also climbs steadily and is projected to be number one by 1990.

The annual growth rates in the number of corporate returns filed show the southeastern, central, southwestern, and western regions to be higher than the national average. Corporation return annual growth rates correlate with area population annual growth rates. The western, south-western, and southeastern regions show steady growth in their share of the nation's corporate tax returns.

FAA Plans for NAS Development

The current NAS evolved to keep pace with the rapidly changing needs of the flying community. In the interest of safety and efficiency, a single system was implemented which is responsible for serving all users after both a military and a civil system were initially developed. In fact, the military system was integrated into the current national system. Terminal area services (approach controls and towers) at most military bases are what remains of the military system. Also, the equipment such as radars and computer systems used by the FAA owes much to early military development.

FAA's Philosophy

The task of creating a single system to serve all users has been difficult, as was pointed out in the first chapter. Most civil users need a

system that takes them from point A to point B on the straightest aerial highway possible. Generally, military requirements are different. Military aircraft leave from, and return to, point A with a tactical delay during flight. Special airspace portions have been created to support these requirements. According to FAA Administrator J. Lynn Helms, the resulting "national airspace system has been created piecemeal . . . to match rapidly changing needs in a timely manner."[71]

The purpose here is not to criticize the NAS development or the current operation of the system. Each user group wants a system that assures its own needs will be met. The private aviation community wants access to the national airspace in an unrestricted environment. The business flying sector of private aviation wants a fair share of controlled airspace. Commercial aviation needs controller service and controlled airspace in order to satisfy the transportation needs of this country's population as a whole. The military users need access to airspace and controller service to most effectively support the needs of national security. All users would like a system that blends safety with economy. Economy requires the most direct routing at optimum altitudes to destinations and special use areas. Deviations from this during a flight or training sortie are costly in terms of fuel and time lost. Discussing FAA programs that will affect the future at a recent air traffic controllers' convention, the FAA administrator stated:

> In one sentence, what is the FAA all about? I've concluded that it is: "The safe and efficient use of the nation's airspace, its facilities, and the vehicles that travel thereon." Safe, because that is our highest and first priority, and one of the two reasons that brought us into existence. Efficient, included second to safety but nevertheless recognizing efficiency in transportation, was the second item which created our organization in the industry. Also, we as an agency cannot abdicate the responsibility we have as regards the economic impact of our decisions.[72]

The purpose of this section is to describe the major plans of the FAA which will change the NAS in the future. The main efforts of FAA long-range planning are to expand the capacity of the NAS. Reorganizations for economy and efficiency are planned, but this study focuses on the physical airspace system. What will the future airways and terminal area structure look like? What new technologies will be used and what equipment will be needed to operate effectively in the future NAS environment? To answer these questions, the current FAA national airspace system plan through the year 2000 is summarized.

NAS users generally agree that the system needs to be improved and expanded.[73] The growth in air traffic is projected to be 40 to 50 percent 10 years from now.[74] "[C]omputers in the Houston and Fort Worth centers might become overloaded, creating traffic delays as early as 1985, with other centers experiencing similar saturation by 1987-88."[75] Most questions about the FAA plan arise from the financing proposals, which call for user financing through airline ticket and aviation fuel taxes.[76] Even though doubts remain about financing, support is developing for the plan from most sectors of the aviation community, except the Aircraft Owners and Pilots Association, which opposes it.[77]

The philosophy used to plan for NAS development was stated by FAA Administrator Helms in the fall of 1981. His philosophy is based on his perception of the current national mood and this nation's values. He feels the taxpayer now wants reduced government costs and regulations with increased productivity. He states, "We are a nation created by seeking personal freedom, and reserving for the private citizen all rights not required by the government for the protection of the country."[78] His philosophy is that the national airspace belongs to the

people of the country and that the FAA is supposed to merely help them to use it safety and efficiently.[79] The FAA is a service organization which will operate under specific guidelines.

> I have established three guidelines that we will use in the future. First, we should control, but not constrain. Second, we should regulate, but not interfere with competitive purpose. And third, we should recognize that most air passengers travel by means of scheduled carriers and, therefore, some priority exists, but never to the extent that it excludes the single individual from enjoying man's greatest achievement: solo flight.[80]

His philosophy has resulted in the new plan for the FAA.

The Plan

The FAA's NAS plan is based on acquisition of new sophisticated computer equipment and computer software which will bring about changes in the airspace structure. The changes will allow more efficient routes and altitudes for point-to-point air traffic. More direct routing, when employed nationwide, is projected to result in a fuel savings of 6 to 10 percent.[81] "Even a 3 percent savings in fuel could translate into a 30 percent increase in airline profits."[82] The business flying segment of general aviation would get similar benefits. A new terminal area organization of about 30 hub centers using new compatible equipment is included in the FAA plans.[83]

This system should increase the high-altitude traffic moving between population centers. The population centers in the southern and western parts of the country have been shown to be expanding rapidly. This indicates what is to be expected in the future. It will be harder for point-to-point traffic to reserve special-use airspace sections at higher altitudes. The automated en route system will probably be less flexible in support of special-use requirements like those of ATC, especially since the lower limits of positive control areas would be lowered.

Implementation

In order to implement the plan, the FAA has developed a sequential approach. First, the current backup FAA computer system--the Raytheon direct access radar channel (DARC)--has to be upgraded so that it can take over as the primary system while new computers are being installed. This should occur between 1983 and 1985.[84]

Next, when the DARC system can take over, the current primary system, IBM 9020 computers, can be replaced with new, more reliable, high-speed hardware that can cope with the air traffic growth of the 1980s. These "host" computers must be able to use the existing FAA computer programs, and the system must have growth capacity to expand automation functions in the future. After the newer, more reliable system is put in place between 1985 and 1987, the DARC system will be removed.[85]

The largest part of the new computer system will be a new multifunction "sector suite" to replace the present Raytheon en route consoles. The same suite will later replace the current terminal area systems which are the Sperry Univac/Texas Instruments ARTS III and the Burroughs ARTS II computer systems. These units are programmable, general purpose data processing systems used in terminal area airspace management.[86] The suite will eventually be used in air traffic control towers also. The en route suites are programmed for replacement beginning in 1988 followed by the replacement of terminal area equipment.[87]

Once the computer hardware is in place with increased capacity, the FAA plans to introduce more efficient software (programs) and increased automation functions. The next software improvement step planned is

implementation of the Automated En Route Air Traffic Control (AERA) program made possible by the increased computer system capacity.

The Concept

Briefly, the AERA concept uses sophisticated transponders on aircraft to communicate with air traffic control computers. The computers are programmed to calculate the optimum flight path for all aircraft within their region in terms of climb-to-altitude and descent profiles, and routes. The computer generates a flight plan clearance for each aircraft, and then the system monitors each aircraft's adherence to its clearance. The AERA system issues updates, as required, if deviations occur that create potential collision situations. Ideally, communications between aircraft and the traffic control system would occur through a data link, but that is not required.[88]

The FAA would like to have the AERA program as soon as possible because of the expected air traffic growth. It appears that the early 1990s is the soonest that AERA can be implemented, with a goal of system-wide operational use by 1996. Early in 1981, the FAA published a report of a study team headed by Lawrence Goldmuntz, president of Economics and Science Planning, Inc., which concluded that

> the concept is feasible, that the degree of automation implied can be achieved with state-of-the-art equipment; that the system can be designed so that no aircraft would be placed in hazard by system failures; and, finally, that AERA has benefits that are substantially larger than its costs.[89]

A source, reported to be an engineer familiar with the project, is quoted by Science magazine as believing it will be more like 20 years before AERA

goes into effect; however, he concluded that the system is feasible and desirable.[90]

As traffic has increased, sector sizes in today's system have been reduced so that controllers can continue operations if the computers fail. With the AERA program in effect, controllers will only monitor the computer-controlled system. This will increase system efficiency to a point that will double controller productivity, thus producing manpower savings.[91] As the AERA system allows the computers to make the decisions, sector sizes will be enlarged and fewer controllers will be needed to support larger volumes of traffic. If the AERA computer fails, the controller most likely will not take over as in today's system.[92]

The new computer systems are projected to save in operations and maintenance costs. Included in the plan is a reduction in the number of air route traffic control centers needed in the future--from 20 to 16. The actual reorganization, however, is not yet firm.[93] In all, the FAA projects a savings from the modernization effort of about $25 billion in operating and maintenance costs over the next 20 years.[94]

Near-Term Improvements

The planned reliability and redundancy within the new system removes the need for a backup system like today's DARC.[95] However, some shorter-ranged parts of the overall FAA plan will enhance the system's near-term and long-term safety and efficiency. Two near-term improvements are mentioned here. The first is that extended "conflict alert" capabilities are planned for the present en route center computers. The system will include aircraft that inadvertently enter controlled airspace so long as they

have a transponder Mode-C altitude reporting capability. By 1985, the en route center computers will provide possible solutions for controllers to choose from to solve potential conflict situations. The second improvement is introduction of computer-devised automatic metering for high-altitude traffic to provide direct descent profiles and approaches in terminal areas.[96]

Another change planned by the FAA is introduction of the threat-alert/collision-avoidance system (T-CAS). This system is intended to help prevent midair collisions. It would also offer a safety factor to cope with a possible AERA system failure. Aircraft will have equipment on board that will warn each other of potential conflicts. Larger aircraft will have T-CAS 2 equipment, which consists of a transponder and airborne radar that is capable of interrogating other transponder-equipped aircraft. Smaller aircraft will have only a transponder and a conflict-warning indicator called T-CAS 1. Two T-CAS 1-equipped aircraft will be warned of the presence of the other aircraft when one transponder replies to a ground-based radar interrogation. Two T-CAS 2-equipped aircraft will be able to automatically exchange position data, and the T-CAS 2 system will suggest maneuver information to avoid conflict. If the conflict is between T-CAS 1- and T-CAS 2-equipped aircraft, the more sophisticated equipment of the T-CAS 2 aircraft will transmit conflict warning to the other aircraft.[97]

T-CAS depends on aircraft having improved transponder equipment. Currently, three out of four active aircraft carry transponders. The cost of the new equipment is estimated to be about $2,500 per aircraft for T-CAS 1 and $50,000 per aircraft for T-CAS 2.[98] The system is scheduled to become

operational by the end of 1984.[99] This method of increasing flight safety is intended to be voluntary; but, depending on participation, its use could become mandatory for aircraft flying in high-density terminal areas.[100]

Work is progressing now to overcome problems with system saturation in dense traffic areas. Many feasible techniques are being researched. The goal is for the T-CAS system to operate in a traffic density of 90 aircraft within a 10-nautical-mile radius.[101]

The T-CAS system depends on the development of an improved transponder system called the Mode-S transponder.

> The principal difference between the new Mode-S transponder and the transponder in use today is that with Mode S, each aircraft has a unique address capability. With the selective address feature, private line air-to-air and air-to-ground data communications can be used in various collison-avoidance applications.[102]

Also, the FAA will install about 137 beacon system interrogators by 1990, of which over 70 percent will be in high-density terminal areas with the rest for en route coverage down to approximately 12,500 feet above sea level in the CONUS. During the next 10 years, installation of about 60 more beacon interrogators will provide coverage down to a mean of around 6,000 feet above sea level over most of the country. By then, FAA plans to stop using the older en route, skin-echo radars and to depend upon the Mode-S system. "This, in turn, will mean that all aircraft operating in en route airspace above 6,000 feet will be required to carry a Mode-S transponder."[103] However, in terminal areas, radar units will be used to control air traffic for some time. The terminal area radars will be replaced with new solid-state equipment as part of the FAA plan.

Another improvement that will be implemented in the NAS soon is the microwave landing system (MLS). The FAA has requested funding for the

initial 15 MLSs to be installed, first in the Boston and Denver hub areas where existing ILS landing systems cannot be used. There will be about 1,250 in use by the year 2000 when all the older ILSs will be shut down.[104]

Other than possible FAA regional reorganizations, two other organizational changes are planned. A sharp reduction in the number of flight service stations, from slightly over 300 now to about 60 by about 1995, is planned by making use of automation aids and remote monitor and communication systems.[105] The introduction of the new computers will bring about a new class of FAA facility. About 30 hub terminal areas are envisioned, to encompass a cluster of nearby terminal areas. For example, "the Washington hub might include Washington National, Dulles, Baltimore, Richmond, and Andrews AFB, Maryland."[106] Approach and departure service outside the hubs will be provided by the regional air route traffic control center.

The FAA plans to enhance NAS efficiency in other ways not mentioned in this study. The points discussed in the study are considered to be the major changes that will affect ATC. In general, the FAA is planning to use modern technology to make the NAS more responsive, more efficient, and less regulatory (as it sees it) while expanding the system's capacity.

Summary

This chapter points out, within some constraints, forecasts of growth in all sectors of civilian aviation. Even though the competition remains highest in the traditional high-intensity areas, rapid growth in Sun Belt areas and the Northwest is expected. A changing mix of major airline commuter, business, and private airspace requirements--stimulated by changes in economic, demographic, and regulatory factors--is evolving.

The growth of the civil part of the NAS converts into increasing workloads for the FAA. The FAA is responsible for managing the system and for supporting all users in a safe and efficient manner. In the past, the system evolved to keep up with a rapidly expanding requirement. Though the future growth in the system will not be as dynamic, a steady growth is forecasted.

In an attempt to stay ahead of the expanding requirement, the FAA is planning to modernize the NAS. The new equipment called for is intended to increase safety and efficiency within the system. Ultimately, the controlled environment will expand. An expanded controlled environment may benefit the military (and ATC specifically) if military needs are included as the system is modernized. Future military requirements are the next part of this study.

CHAPTER III

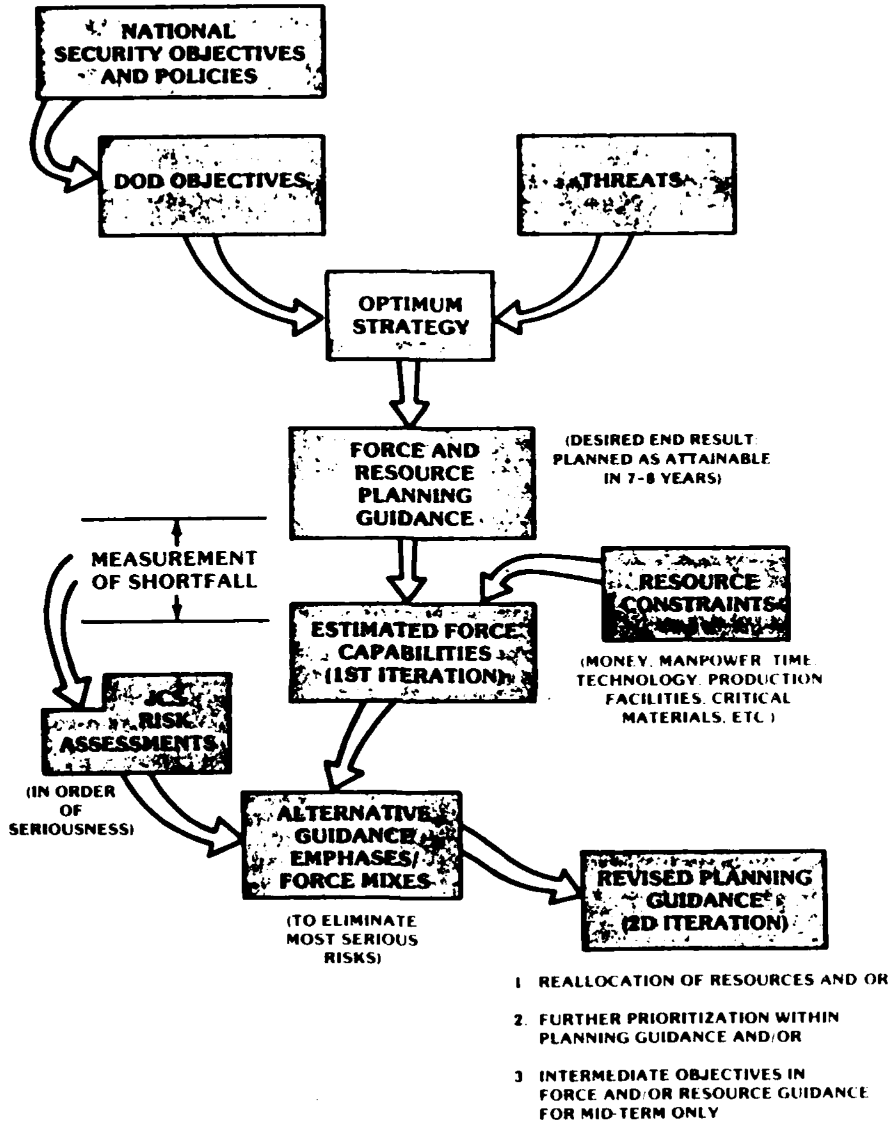
FUTURE MILITARY REQUIREMENTS

The purpose of this chapter is to review the military aviation force structure, to anticipate possible changes to its flying programs, and to review special military airspace management requirements. The scope of this study is limited to airspace and controller services required within the CONUS. The purpose of this study is to give an unclassified overview of future military airspace requirements. Specific planning actions should be coordinated with appropriate Air Staff organizations.

The planning effort of the government, and particularly the DOD, is a dynamic process which depends on national security objectives, policies, and an assessment of the global geopolitical situation each year.[1] The recent changes in global relationships between oil-exporting and oil-importing countries are obvious examples of how dynamic the planning environment is and how quickly geographical interests and planning goals can change. The steady technological improvement and force growth of the Soviet Union is another changing factor that influences the DOD's annual planning process and, ultimately, military airspace requirements. The steady improvement and the force growth of the Soviet Union and its allies put pressure on the United States to expand and modernize its forces.

The limitations and uncertainties associated with forecasting future events were discussed at the beginning of the last chapter. Even though these limitations are acknowledged, this chapter looks at the anticipated future structure of military flying forces, using Secretary of Defense Caspar W. Weinberger's Annual Report to the Congress, Fiscal Year 1983 as the basic source.

FIGURE 26. The Defense Planning Process



Source: Caspar W. Weinberger, Annual Report to the Congress, Fiscal Year 1983.

The timing and the rate of economic recovery from the current recession will surely affect funds allocated to military budgets and, in turn, future force structures (and airspace requirements). These future force structures, it must be pointed out, are also influenced by congressional (political) pressures[2] which make rational military planning more difficult and less certain.

In addition to economic factors, which have an impact on the size of military forces and the amount of flying training time available to the military, qualitative training needs will influence future military airspace requirements. For example, with relatively less flying time in which to practice, the military will be less flexible in its ability to yield to civil traffic. The type of airspace needed is also changing. Military training concepts are dictated by necessary changes in operational tactics caused by threats our forces will have to be prepared to face in the future. More training has to be done in realistic, night, and low-level airspace environments to assure future readiness.

This chapter begins by giving an overall review of military participation within the NAS. Possible changes in the amount and type of airspace and controller service needed by DOD forces are included. Then each specific service is discussed (including a brief look at Coast Guard activities). Air Force needs, and potential changes to them, are presented by major command (MAJCOM).

General Trends in Military Participation

The DOD participates actively in the control of all aircraft within the NAS. The primary role played by the DOD in NAS development was discussed in the first chapter. The current military air traffic control force "represents the second largest air traffic control activity in the Free World--second only to the FAA."[3]

A comparison of personnel numbers should demonstrate the relative size and growth of the FAA and military traffic control organizations. The number of field personnel employed by the FAA grew from about 46,700 in 1970 to about 51,400 in 1979. The total has been fairly constant since 1975.[4] About half of these people are involved in air traffic control. The actual controller force goal is about 13,000. Personnel of the Army, Navy, and Air Force are also involved in air traffic control. Table 13 shows military controller strength. Within this country, there are nearly 6,900 military controllers. For comparison, the Air Force controller force has been reduced from about 6,500 in 1970 to about 5,100 at the present time.[5] Thus, while the FAA force has grown, Air Force controller strength has declined.

During the recent FAA controller strike and subsequent firings, the DOD responded by augmenting the FAA forces. Over 1,000 military personnel worked at nearly 120 FAA facilities[6] to assure safety in the skies. Augmentation is expected to continue as needed. The eight augmentation increments are shown in Table 14. The assistance is authorized by the Federal Aviation Act, which acknowledges the criticality of an effective

TABLE 13. Military Air Traffic Control Posture

CONTROLLER STRENGTH	CONUS	OVERSEAS	TOTAL
Air Force	3,731	1,361	5,092
Navy/Marines	1,932	964	2,896
Army	1,205	467	1,672
TOTALS	6,868	2,792	9,660

TABLE 14. DOD Augmentation

INCREMENT	USAF	NAVY	ARMY	TOTAL	LOC
1	90	0	10	100	5
2	155	55	60	270	10
3	23	0	0	23	4
4	75	15	15	105	5
5	68	7	75	150	15
6	77	39	46	162	19
7	14	0	0	14	3
8	110	48	42	190	56
TOTALS	612	164	248	1,014	117

SOURCE: Briefing given by HQ USAF/XOOTF, Majors Ball and Gaunt, to Mr. Fenello, February 1982.

NAS to national security.[7] The intent of this legislation demonstrates the close relationship between the military and the FAA within the system.

The military establishment is the largest single manager of aircraft and pilots in the NAS. The DOD operates nearly 20,000 aircraft within the CONUS and has nearly 50,000 pilots. Table 15 illustrates the number of each type aircraft possessed by each service. Noteworthy is the fact that over 70 percent of Air Force, Navy, and Marine aircraft are fast, maneuverable, high-performance jet airplanes. About 93 percent of the Army's aircraft are helicopters. The Air Force logged most of the 5.25 million flying hours flown by the DOD in the United States in 1981. Since 1971, the number of military aircraft has decreased by about 5 percent, and flying hours have declined by over 40 percent. Table 16 compares monthly flying hours per pilot in selected aircraft in 1971 and 1981. The trend has been toward Air Force pilots receiving less flying time. This is mostly due to economic considerations. Unfortunately, these reduced flying hours impact negatively on force readiness.[8] To counter this, "increased flying hours for all the services were programmed into the Fiscal Year 1983 budget."[9] "In the coming fiscal year, the Air Force will increase tactical flying hours by 8 percent, bringing the average flying hours per pilot up to about 18 hours per month compared to less than 15 in 1980."[10] This is still less than what was experienced in the past.

Most military flying during peacetime is for training purposes. There are three phases in military flying training. First, there are the initial courses such as pilot and navigator training. The second phase involves advanced training in mission aircraft. Qualified aircrews then fly to maintain proficiency, to gain experience, and to learn the tactics

TABLE 15. DOD CONUS Aircraft and Flight Hours--1981

	Jet	Turbo Prop	Piston	Helo	Total
Air Force	6,870	825	305	208	8,208
Navy/Marine	2,342	742	208	1,055	4,347
Army	0	420	71	6,748	7,239
	9,212	1,987	584	8,011	19,794

Flight Hours

	Million	CONUS 81
Air Force	2.75	
Navy/Marine	1.55	
Army	.95	

TABLE 16. Monthly Flying Hours Per Pilot In Selected Aircraft

	1971	1981
B-52	57	24
F-4	19	14
C-141	34	25
F-15	-	15
F-16	-	13

SOURCE: AF/XOOTF Briefing To Mr. Fenello

required to insure their readiness to perform their wartime mission. This proficiency flying accounts for about 60 percent of military flying.[11]

The ultimate goal of all flying training is to maintain a readiness to fight and win any war. This calls for the most realistic training possible, which requires adequate airspace and controller support for safety and efficiency.

The type of training needed is influenced by the threat presented by the Soviet Union and its allies. The threat in the European arena is the primary concern, but any potential military action would most likely involve Soviet-equipped adversaries. A fight in Europe might require US aircrews to fly and fight in adverse weather conditions, a situation possibly advantageous to the Warsaw Pact countries. Outnumbered North Atlantic Treaty Organization (NATO) ground forces would depend on air support. There must be a capability to provide this support at night as well as during daylight hours and under poor weather conditions. The military services need controller support in the NAS to conduct realistic training under such conditions.

To be effective against the sophisticated ground-to-air defensive systems of our adversaries, our aircraft must fly at extremely low levels. Thus, military aircrews must be prepared by undergoing realistic training at low altitudes. Low-altitude flights, especially those at hign speed, are the most hazardous. Nevertheless, such realistic training is necessary, even though low-level flights make two air traffic control tools--radar detection and reliable communications--difficult or impossible.

Thus, the trend in the future will require all the services to do more training at night, at low level, and in all types of weather. This

satisfies the primary objective of peacetime training to provide realistic training. Most of this training can continue to be accomplished near local units in existing special airspace, since this is the most efficient use of military resources (which ultimately belong to the public).

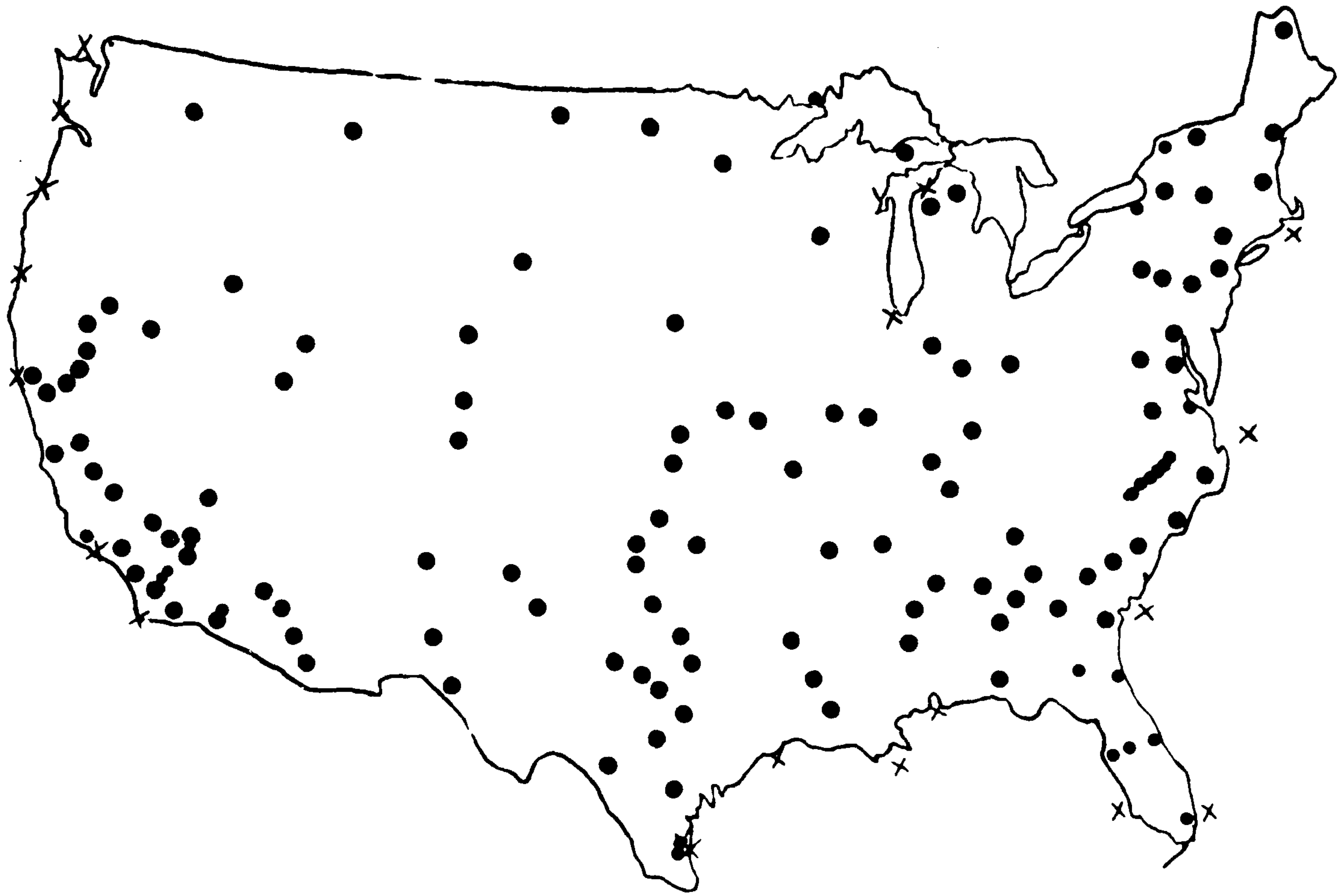
Experience in Vietnam showed that realistic training is essential. The 10-to-1 air-to-air kill ratio favoring the United States in the Korean conflict dropped to a 2-to-1 ratio in Vietnam. The lack of realistic training proved to be the primary cause. Most American losses were aircrews with experience in less than 10 combat missions.[12]

Realistic training also requires the massing of forces and joint operations. For this reason, local area training is enhanced by special programs such as Red Flag and other exercises. In these situations, aircrews may train more effectively under conditions that include realistic threat simulation and the large-scale, joint force operations. The FAA's Central Altitude Reservation Facility is very cooperative in supporting these operations when exercises or deployments are required.

The major DOD flying areas are shown in Figure 27. There are about 220 locations with active duty units flying. In addition, National Guard and Reserve forces operate from about 120 civilian airfields. Many fields have more than one unit flying actively from it. Each unit requires airspace for unique military training activities. In addition to flying activities, operations such as missile firings, artillery, and special test activities require special airspace.[13]

To support military training, certain airspace areas have been depicted on aeronautical charts. Table 17 shows the number of each type area. The special-use airspace areas are shown in Figure 28 and are

FIGURE 27. Military Flying Locations



defined as restricted areas, alert areas, and Military Operations Areas (MOAs). The restricted areas are reserved for military operations in order to protect nonparticipants from hazardous activity occurring in the area. Over 80 percent of these areas are used by the Army for nonflying activities.[14] Military flying activities that take place in restricted areas are hazardous to other aircraft. For example, air-to-ground munitions may be dropped or air-to-air gunnery may be taking place.

Since 1959, restricted airspace has been reduced from about 144,000 square miles to about 75,000 square miles--a reduction approaching 50 percent. DOD organizations are making better use of restricted airspace by taking other steps which enable all civil users to fly through restricted and warning areas whenever possible. (Warning areas are located over water in international airspace. They are restricted, but no munitions are delivered in them.) For example, over $200 million have been spent to enhance military air traffic control capabilities at restricted areas near Las Vegas, Nevada, and the Utah Test Training Range in northwest Utah. Navy controllers have opened offshore warning areas to civil traffic. Currently, 88 percent of all restricted airspace areas are available for joint use.[15]

Alert areas are depicted on aeronautical charts to warn pilots of areas of high-density flying training. Other aircraft are not restricted from flying in these areas. A good example of an alert area is near Fort Rucker, Alabama, the center for Army and Air Force helicopter pilot training. These Army flying activities (about 95 percent) and a very small percentage of other military flying activities, such as helicopter and slower fixed-wing aircraft flying operations, generally fit better into

TABLE 17. Charted Military Airspace

Designated Special-Use Airspace	
Warning Areas	98
Restricted Areas	270
Military Operations Areas	170

Other	
Alert Areas	29
Instrument and Visual Military Training Routes	475
Air Refueling Routes	147

SOURCE: Briefing given by HQ USAF/XOOTF, Majors Ball and Gaunt, to Mr. Fenello, February 1982.

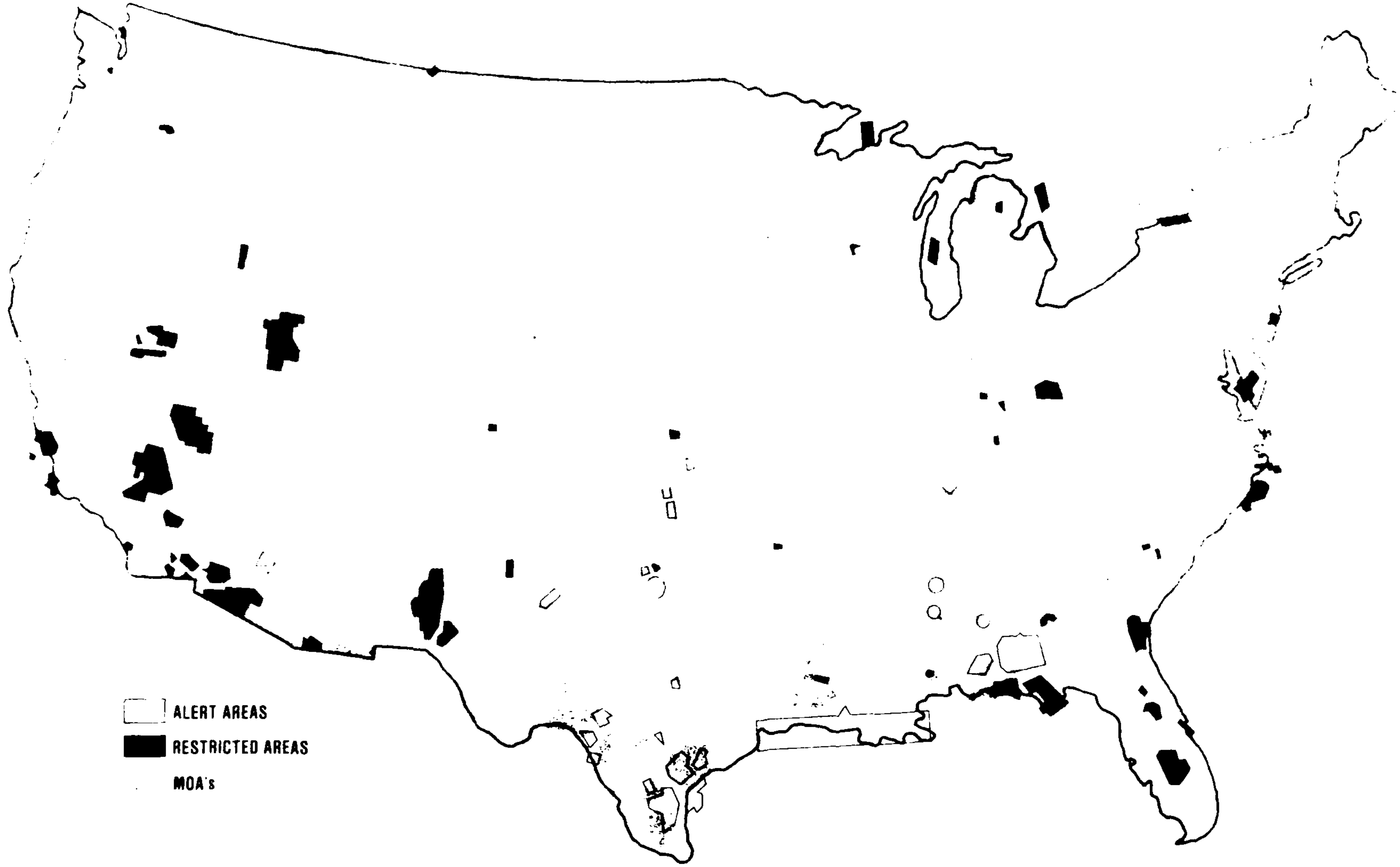


FIGURE 28. Special-Use Airspace

the uncontrolled VFR flying environment. This avoids the cost and complexities of special arrangements such as MOAs, military training routes, or restricted areas.

MOAs, shown in Figure 28, resulted from the combined efforts of the FAA and the DOD. MOAs constitute one of two programs designed to warn civil aircraft pilots where military activities involving unusual maneuvering or speeds are taking place. No restrictions are placed on the uncontrolled "VFR" pilot. The operational status of a military operations area may be determined by simply calling the nearest flight service station. The civil pilot can then plan to avoid the area or fly through it, aware of the activity present. Air traffic controllers do separate controlled "IFR" traffic in these areas. Controller actions can restrict flying operations in these areas.

Each MOA is unique. Some have only one military user (or one base) while others are used by many different organizations. Some are used by more than one service. FAA operations and support are different in each MOA. Letters of agreement are "negotiated" between users and the controlling FAA facility. In some cases, MOAs are restricted from other users when military activities are operating within them. In other cases, military activities may be directed to give way so that other users may transit the areas. Increased civil air traffic puts pressure on controllers to allow civil aircraft to transit these areas.

The other program to warn civil airspace users of military traffic involves military training routes for low-level navigation training. They are designated VR and IR routes. The former does not have IFR control (separation from other controlled aircraft) available and can be used only

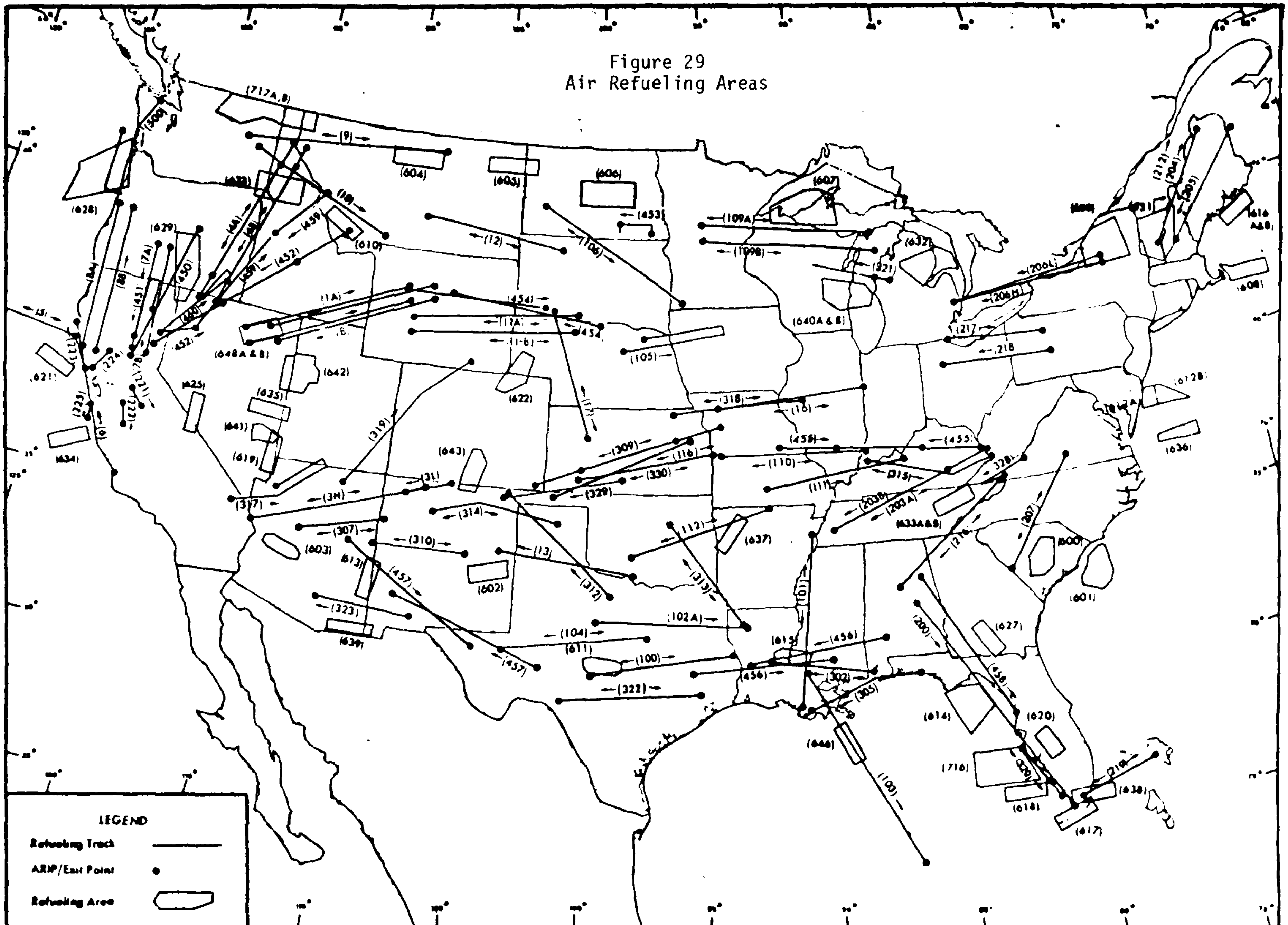
in visual flying conditions. The IR route uses FAA control and separation service. The civil pilot would use the same procedure to find if a particular route were in use. He or she would then proceed with an awareness of any military training activity, without restrictions if on an uncontrolled flight and most likely above any restriction if on a controlled one.

In all cases, controlled civil aircraft (those operating under IFRs) are separated from controlled military air traffic within the single system. Separation is assured by placing restrictions on the individual controlled aircraft. For example, the military pilot may be given instructions to maintain a specific altitude until the other controlled traffic is clear.

All high-altitude military traffic operates within the FAA-controlled portion of the NAS. The training areas on top of MOAs are called Air Traffic Control Assigned Airspace Areas (ATCAAs). Also, air refueling practice generally takes place in special high-altitude IFR airspace on air refueling tracks and in "anchor" areas shown in Figure 29. Air refueling accounts for about 100 missions a day. Most military aircraft operate extensively in the high-altitude controlled environment and strictly comply with federal regulations. Military aircraft use the controlled FAA system to the maximum extent possible in the interest of flying safety for all NAS users.

Many of the special military operations occur as close as possible to the home station in order to provide realistic training most efficiently. Therefore, the location of military flying activities is relevant to this study. Figure 27 illustrates where the airfields used as bases

Figure 29
Air Refueling Areas



for military units are located within this country. Over 50 percent of all DOD basing is within 100 miles of the three sea coasts (Atlantic, Pacific, and Gulf). Base locations are spread out, relatively uniformly, except for a few locations mostly within coastal areas.

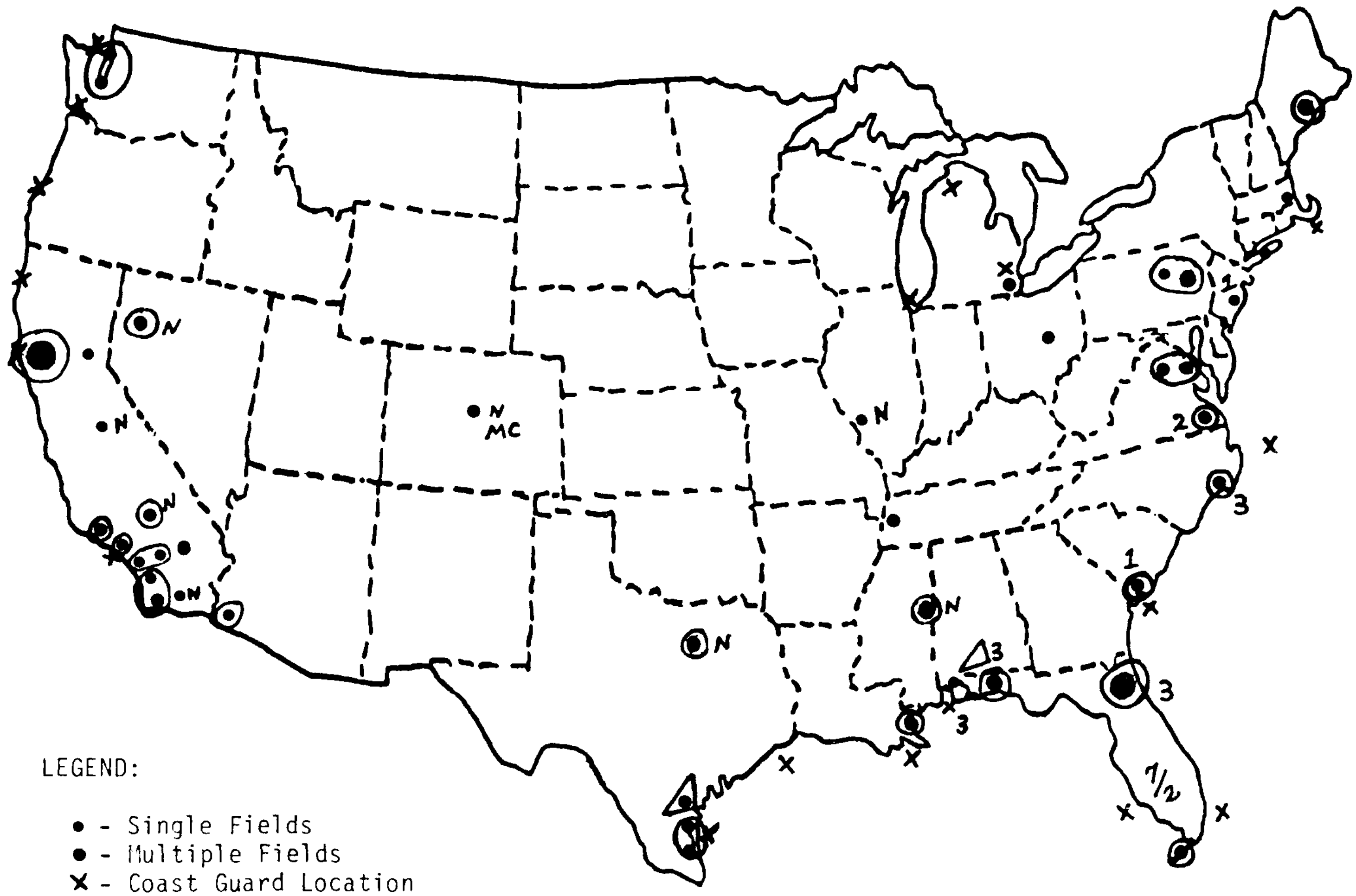
When speaking of training locations "close" to home station, some explanation is required. In many cases, "close" is a relative term. For example, a Strategic Air Command (SAC) bomber stationed at Pease AFB, New Hampshire, would have to travel over 300 miles to use the closest low-level bombing training areas available, and often it would travel around 1,000 miles. (Planned improvements in this situation are discussed later.) Also, military units often travel to locations far from home station to get the required realistic training. Deployment exercises, joint training exercises, and readiness evaluation exercises are a few examples of operations that generally require operations distant from home station.

Next, specific military flying locations and possible future force structure changes are summarized. The intent is mainly to show where terminal activities are and explain more fully what future changes and competition may be expected for ATC planning purposes. Special-use flying areas shown earlier in Figure 28 are also considered. These special-use areas, as well as terminal areas, are often jointly used. In any future planning for base structure or airspace requirement changes, coordination with the DOD is absolutely essential. Airspace could easily be the limiting factor in the effectiveness of a base or location in the future. The following information will therefore give a general insight to DOD force locations, airspace requirements, and possible changes that may be expected. The flying locations shown are all aerodromes with an instrument approach procedure or radar capability.

Maritime Forces

The Navy, Marine Corps, and Coast Guard fly mostly from coastal locations as noted in Figure 30. There are 38 Navy fields. In addition, naval active duty units operate from one Air Force base, three Air Guard and Reserve bases, and three private fields. That totals 45 Navy flying locations in the CONUS, 10 of which could be considered inland. Nearly 80 percent of the Navy's CONUS bases are in coastal locations. In addition, a large portion of the Navy's aircraft are carrier-based. These aircraft carriers are at sea a good part of the time. In their current deployment, the Navy has one aircraft carrier for the Western Pacific and two for the Indian Ocean in the Seventh Fleet. In the Eastern Pacific region, the Third Fleet has four aircraft carriers; and in the Atlantic, the Second Fleet has five aircraft carriers. The Sixth Fleet in the Mediterranean has a single aircraft carrier.[16] Twenty-four patrol squadrons round out the major portion of the Navy's operational aviation force.

FIGURE 30. Navy, Marine Corps, Coast Guard Locations



LEGEND:

- • - Single Fields
- ● - Multiple Fields
- X - Coast Guard Location
- O - Major Flying Location
- N - Navy
- MC - Marine Corps
- Δ - Training Location

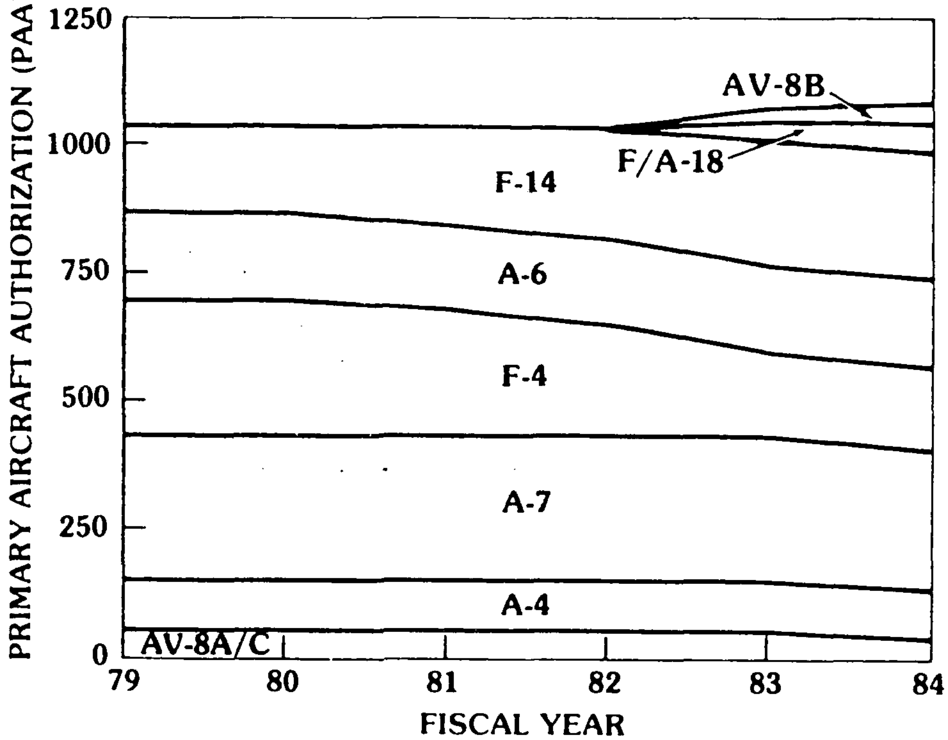
Navy air wings are task-oriented and are made up of a mix of aircraft. The typical carrier air wing has the following aircraft:

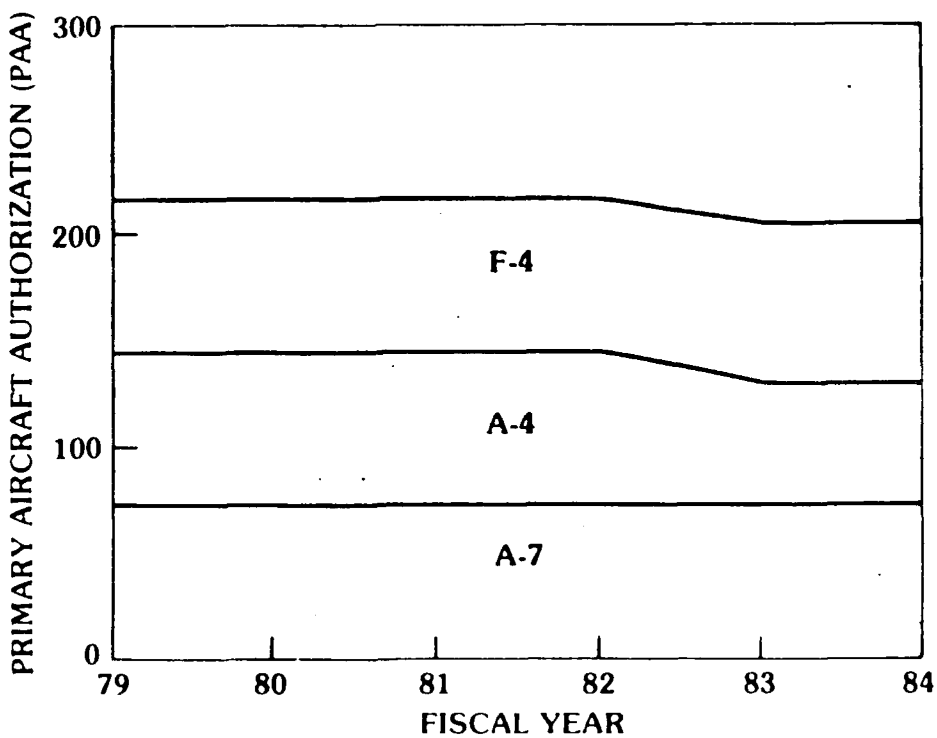
Aircraft Type	Function	Squadrons	Aircraft
F-4, F-14 (TARPS)	Fighter (Reconnaissance)	2	24
A-7, F/A-18	Light Attack	2	24
A-6, KA-6D	Medium Attack, Tanker	1	14
S-3A	Antisubmarine Warfare (Fixed Wing)	1	10
SH-3H	Antisubmarine Warfare (Rotary Wing)	1	6
EA-6B	Electronic Warfare	1	4
E-2C	Airborne Early Warning	1	4
TOTAL		9	86

The DOD plans to increase the Navy aircraft carrier force to a total of 15 and has added funds for two new carriers in the Fiscal Year 1983 budget. The next one could be completed by 1986.[17] There are also two Reserve carrier air wings.[18]

Even though the Navy is increasing its force structure, the actual growth is not great. Figure 31 shows Navy and Marine fighter and attack aircraft quantity projections. Through Fiscal Year 1984, primary aircraft authorized for active units increases by about 50, while the Reserve totals decrease by about 15. Another aircraft carrier wing in 1986 or 1987 would add about 85 aircraft. A great deal of the future defense budget will be

FIGURE 31. Department of the Navy and Marine Corps Active Fighter/Attack Aircraft





used to modernize aging equipment. Major elements of the Navy's modernization program are replacing aging F-4s and A-7s with F-14s and F-18s. About 10 A-6E aircraft per year will replace older A-6s which will be converted to KA-6 tankers.

The Navy's studies show that maritime patrol aircraft are important to antisubmarine warfare efforts. About five P-3s will be purchased each year through 1987 to support this effort. These new aircraft are intended to modernize the force, which should not grow overall until after the early 1990s. Also involved in supporting the antisubmarine effort are helicopters. Slightly over 200 SH-60B helicopters are programmed to replace the Navy's SH-3s over the next 4 years.[19]

A good deal of the competition from the Navy for airspace would most likely come from its pilot training program. Navy pilot training operations in Mississippi and south Texas are near Air Force training bases. If the Navy gets the additional aircraft carrier forces desired, it will need to train more pilots than the 1,500 per year it trains now.

Navy personnel are continuing to purchase Beech T-34C aircraft and are asking for an additional 30 in Fiscal Year 1983.[20] They continue to replace aging T-28s with the T-34C and are planning to replace their jet trainers in the mid-1980s with a single new aircraft (VTXTS). Currently, the Navy uses about 800 T-28, T-34C, T-2, T-4, and T-44 aircraft in its fixed-wing training programs.

The Navy's goal in the 1990s is to have a structure of 15 aircraft carrier battle groups and a 600-ship force. Plans call for only three new type replacement aircraft and improvements to existing airframes not replaced. Future DOD programs are intended to replace multiple existing

airframes with a single aircraft type. The first, the JVX, will replace the Navy and Marine CH-46 and the Army Mohawk aircraft. One candidate for this program is a version of the Bell Helicopter Textron XV-15 tilt-rotor aircraft. The second, the VFMX, is a program to replace both the F-14 and A-6E all-weather attack aircraft with aircraft that will be operational in the late 1990s. Candidates for this program may use forward-swept or oblique-wing technologies. The third program would replace three aircraft: the E-2C airborne early warning aircraft; the C-2 carrier on-board delivery aircraft, the Marine troop transport; and the S-3 antisubmarine warfare (ASW) aircraft. The replacement would be a vertical or short takeoff-and-landing aircraft which would enter development in the late 1990s.[21]

The Marine Corps operates units at 10 locations that are Marine fields and at one Air National Guard field. The only locations that could be considered inland are at the air-to-ground combat center at Twentynine Palms, California, and the air station at Yuma, Arizona. The Marines are also tenants at Buckley Air National Guard Base near Denver, Colorado. These Marine flying locations, like the Navy's, are located throughout the country but concentrated in coastal areas.

Marine tactical flying force growth was included in the Navy's figures previously shown through 1984. The typical Marine air wing consists of the following:

Aircraft Type	Function	Squadrons	Aircraft
F-4, F/A-18	Fighter/Attack	4	48
A-4, AV-8A/B/C	Light Attack	2-3	38-57
A-6	Medium Attack	1-2	10-20
KC-130	Tanker/Transport	1	12
EA-6B	Electronic Warfare	1	4
RF-4	Reconnaissance	1	7
OV-10	Observation	1	12
AH-1	Attack Helicopter	1	24
CH-53, CH-46 UH-1	Transport/Utility Helicopters	6-7	131
TOTAL		18-21	286-315

There are three active and one Reserve Marine air wings. In the 1990s, the F-18 is programmed to be a replacement aircraft in all fighter and attack units for the F-4 and A-7 aircraft. The AV-8B vertical/short takeoff-and-landing aircraft will replace older Marine AV-8A, AV-8C, and A-4M aircraft.[22] Additional procurement of CH-53s (funding for 50 from 1981 through 1984) is planned.[23]

Beyond 1984, the present DOD plan will increase tactical Navy and Marine aircraft by about 9 percent, from roughly 1,770 to 1,930 aircraft by 1987, with the last carrier group to follow. Whether this total is achieved remains to be seen. The total of 15 aircraft carrier groups seems to be the upper limit with 13 or 14 more likely. Not only is the cost a constraint but the added manpower requirements to support this large a

naval force would be difficult to achieve, given fewer young people to recruit from and economic considerations. A poor economic situation helps recruiting and retention, but it does not support expensive acquisition programs like purchasing aircraft carrier groups. If the economy gets better and the three new carrier groups become affordable, then recruiting and retaining the manpower to support them will become a problem.

Marine Corps divisions, which are supported by their air wings, are located at Camp Pendleton (north of San Diego, California) and Camp Lejeune (north of Wilmington, North Carolina). These areas, again coastal, would have some helicopter-support activity. The Marine Reserve division is located near New Orleans, Louisiana.

Certain conclusions can be drawn. The Navy and Marine operational flying requirements for airspace will generally not be a problem for the Air Force or ATC. Relatively modest growth and peripheral operating locations are the dominant factors generating Navy and Marine airspace requirements. However, Navy and Marine pilot training programs could be a different matter. Cooperation with Navy training bases will be needed in the future to coordinate airspace requirements.

Similar conclusions can be made about the Coast Guard, which is included here because it is a military service and a branch of the Armed Forces of the United States.[24] Briefly, the <u>DOD Flight Information Publication</u> lists 19 fields or heliports where Coast Guard flying units are located in the 48 contiguous states. (There are also three Coast Guard aircraft located at the Washington National Airport.) These locations were included in Figure 30 and are all at coastal locations or on the Great Lakes.

The Coast Guard's pilots are trained initially by the Navy at Pensacola Naval Air Station in Florida. Then they go to either fixed-wing or helicopter transition training at the Coast Guard Aviation Training Center at Mobile, Alabama. Currently, there are about 700 pilots in the Coast Guard.

The Coast Guard's plans include the purchase of 90 new HH-65A Dolphin helicopters by early 1986. Also, the Coast Guard is purchasing Dassault-Breguet HU-25A (Falcon 20 Class) medium-range surveillance aircraft, but modifications have to be made to the Garrett ATF3-6 turbofan engines for these aircraft to meet Coast Guard specifications.[25] Coast Guard funds have been in jeopardy in the current budget process but will probably be reinstated because of the necessary services they provide. The total Coast Guard flying force includes about 150 aircraft and helicopters and could climb as high as 200 in the late 1980s, with about 125 helicopters and about 75 fixed-wing aircraft. If Coast Guard funds are reduced, their aircraft numbers could be reduced; and the stations at Savannah, Georgia, and Los Angeles, California, seem to be the most likely candidates for closure.

Army

As previously seen in Table 15, about 93 percent of the 7,300 US-based Army aircraft are helicopters. In fact, about 95 percent of all Army aviation operates in the visual flying environment,[26] which does not use en-route controller support. Most Army flying activities take place at very low altitudes, below where ATC normally operates. This supports the goal of providing realistic training for the Army.

The Army's battlefield doctrine is to fly at low level, to follow the contours of the terrain, or to fly "nap of the earth." These tactics, demonstrated in Figure 32, take advantage of the masking provided by hills, valleys, trees, or other objects on the ground. The Army also flies at night with no lights, using special night vision systems. As already mentioned, these tactics are designed to meet the threat posed by our adversaries. In order to operate visually in poor weather (cloudy and low visibility) conditions, the Army has special arrangements with FAA centers so its aircraft may rapidly change to IFR and recover if required.[27]

The Army needs restricted airspace for nonflight activities such as missile firings, artillery, and special test activities which are hazardous to all aviation. In fact, 80 of the 270 restricted areas are used for these activities.[28]

Even though Army aviation units are spread throughout the CONUS, remember that Army flying activity is mostly done at low altitudes under VFR. Thus, there is little conflict with Air Force flying activities. Figure 33 shows the 37 Army airfields or heliports as well as the location of Army air units at 3 Navy, 1 Air National Guard, and 6 Air Force fields. In addition to these, there are Army aviation facilities at 1 Army Reserve, 7 National Guard, and 17 private fields. This makes a total of 67 locations for Army flying operations. Nine divisional headquarters are circled to highlight particularly active areas in addition to the area around Fort Rucker, Alabama.

The current defense program allots funds to buy additional quantities of weapon systems for the Army to include helicopters. The report,

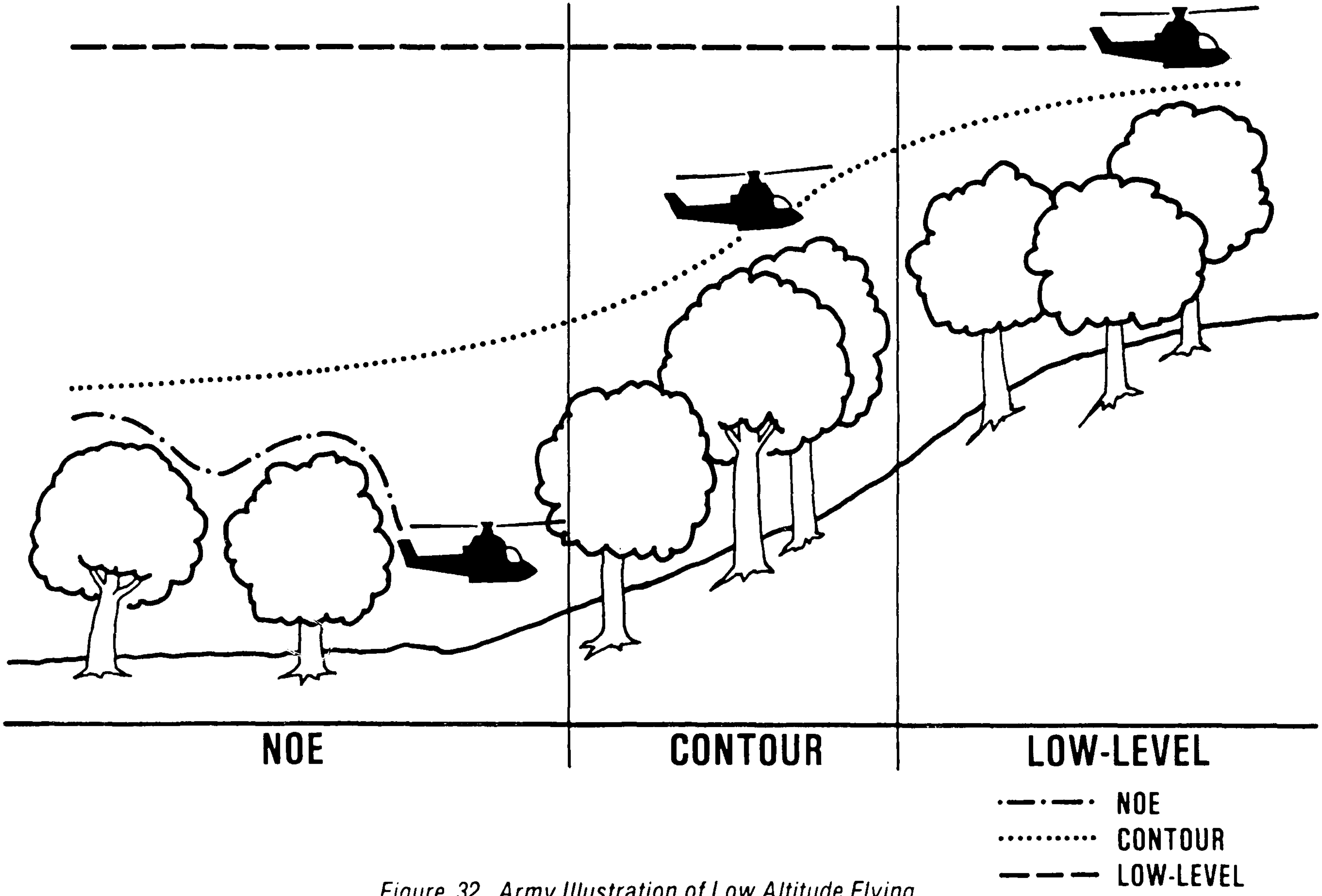
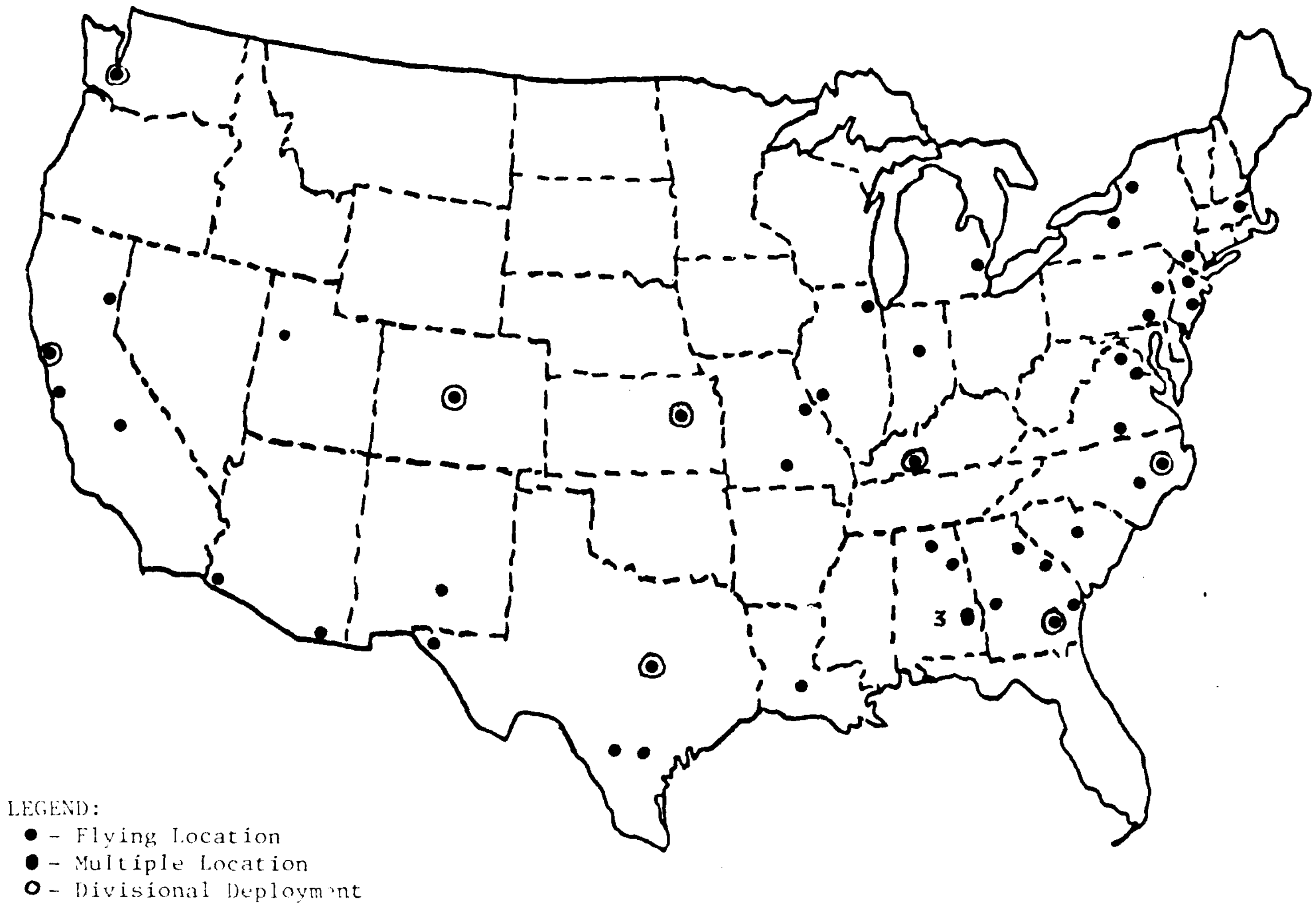


Figure 32. Army Illustration of Low Altitude Flying

FIGURE 33. Army Flying Locations



submitted to Congress for the Fiscal Year 1983 budget, calls for "25 percent more attack helicopters and 11 percent more utility helicopters" over the last Carter plan.[29] The new helicopters are being used mostly to modernize the Army flying forces. The fleet of Cobra-Tow (AH-1S) helicopters has been formed by modifying AH-1G gunships and buying new AH-1Ss. The UH-60A Black Hawk program is to replace some of the aging UH-1 Hueys, and the AH-64 advanced attack helicopter is planned to become operational in the mid-1980s. The main thrust of current plans is for <u>modernization</u> and "will not allow for much expansion of Army force levels."[30] The total Army helicopter force outlook is for possible increases of about 5 percent by the end of the 1980s.

In summary, even though Army flying locations are spread throughout the United States, the great majority of Army operations should not compete with ATC airspace needs. Army airspace needs will grow slightly, but operations are below the altitudes needed by ATC in most cases. The Army's relatively slow visual operations will not compete with ATC for en route controller services.

Air Force

Air Force flying unit locations and potential force and airspace requirement changes are presented next. Each of the three operational flying commands is discussed. Other Air Force needs as well as the locations and sizes of Air National Guard and Air Force Reserve forces are included.

Mobility Forces of Military Airlift Command

> They arrived at 6:07 a.m., on time to the millisecond. Thirty-two high-winged Air Force C-141 Star Lifter jets screamed out of the morning sun, flanking a lunar-like peak protruding from California's Mojave Desert. They came in just 800 feet off the ground, throttled back to a bare minimum 135 knots, dropping 800 paratroopers toward landing zones designated "Gold" and "Silver."[31]

A Newsweek article began with this statement when describing the recent Bold Eagle exercise. It illustrates the fact that Military Airlift Command (MAC), unlike an airline company, often flies its aircraft in support of strictly military missions. Some missions do follow point A to point B routes like commercial airlift, but MAC supports many unique military flying requirements which do not resemble an airline operation at all. MAC conducts extensive air refueling operations to expand the range of its C-5 and C-141 force. The last of its C-141s should be modified for air refueling by the end of 1982.

A growing airdrop requirement is unique to MAC. Virtually all crews who fly airlift C-130s, including Air National Guard and Air Force Reserve personnel, are involved in training that includes airdrop of personnel and equipment. The C-141 airdrop capability has recently been expanded. MAC performs airdrops for the Army at over 2,000 drop zones in the United States. These airdrop missions generally have been flown at medium altitudes.

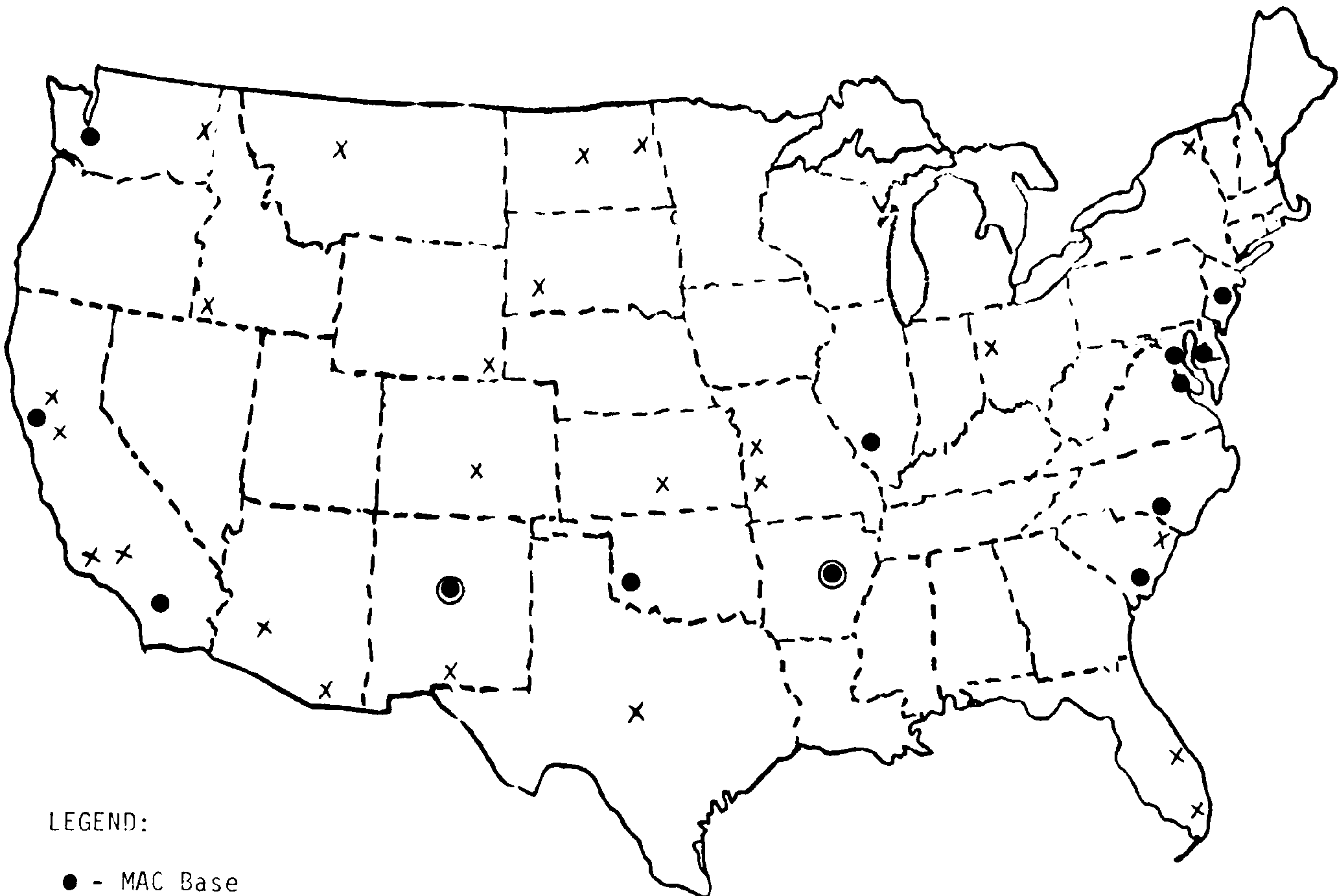
MAC has begun training at lower altitudes, as illustrated by the opening quote, to enhance realism and to develop tactics needed to survive in today's battlefield environment. Special low-altitude profiles, below 1,000 feet, are practiced by C-130s and C-141 aircrews. Missions operate visually, using airborne radar to navigate to drop zones. They fly at altitudes as low as 300 feet above the ground. These missions use terrain masking, which avoids ground radar and other threats, to make airdrops and then leave a simulated threat area safely. This low-level, VFR mission is not supported by FAA en route air traffic controllers.

MAC flies about 500 missions per day. Over 50 percent of these missions involve some sort of special activity.[32] MAC operates 13 bases across the country (there is no flying at Bolling AFB, Washington DC) and has tenant units at 28 others (Figure 34). Its upgrade training programs are at Kirtland AFB, New Mexico, which is Albuquerque International Airport (helicopters and HC-130s); Altus AFB, Oklahoma (C-5s and C-141s); and Little Rock AFB, Arkansas (C-130s). In all, MAC has just under 1,000 aircraft with about 50 C-130s normally based out of the country.[33]

Between now and Fiscal Year 1987, the airlift fleet is expected to expand to correct shortfalls in airlift capacity. The current C-5 wing modification program will extend the life of these 77 aircraft well into the twenty-first century. The DOD proposes to buy 50 more C-5s (together with the proposed 44 additional KC-10s) to satisfy present long-range mobility needs. The Senate, especially Senator Henry M. Jackson, has given strong support to the purchase of Boeing 747s instead of the additional C-5s. The principal point is that heavy airlift resources will be added to the Air Force (MAC's) inventory over the next 5 years.[34] In addition, C-17 development is still needed since planned phaseout of the C-130 force in the early 1990s would leave an unacceptable shortfall in intratheater airlift capacity. Air Rescue Service will be replacing its HH-3 helicopters with the HH-60D Night Hawk, a derivative of the Army's Black Hawk.

The trends for MAC are for increased numbers of aircraft, probably on the order of 5 percent. Like other military units, MAC will increase its participation in special activities such as aerial refuelings, low-level navigation, and exercise support operations in special airdrop areas. This will be multiplied by more training flight hours for aircrew members.

FIGURE 34. Military Airlift Command's Flying Locations



LEGEND:

● - MAC Base
X - Tenant Base
O - Training Location

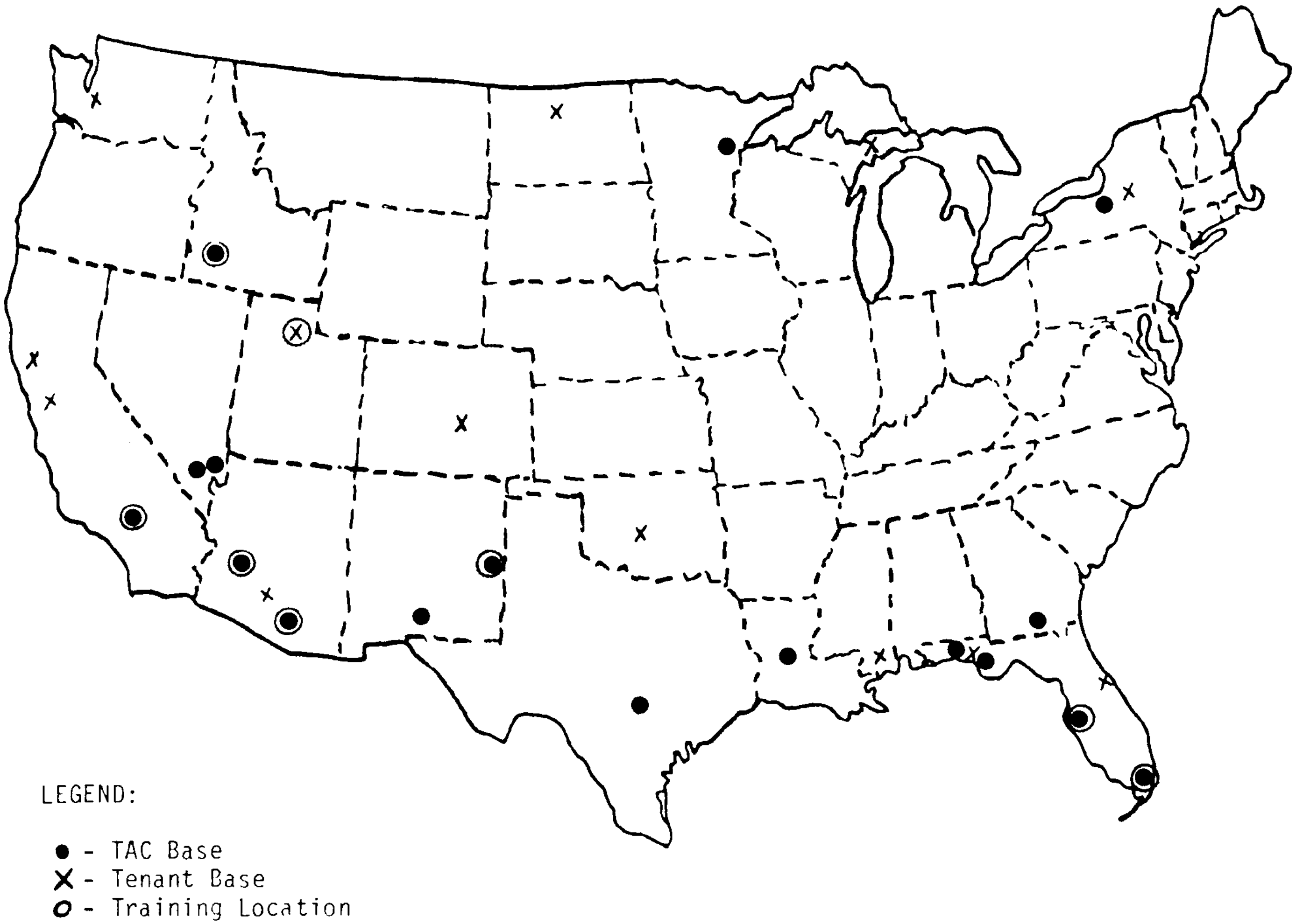
Tactical Forces of Tactical Air Command

United States Air Force (USAF) tactical aircraft are stationed worldwide, from Korea and the Philippines in the Pacific Air Forces (PACAF) to the NATO countries in the United States Air Forces in Europe (USAFE). Forty squadrons, which are about 50 percent of the primary active tactical forces, are stationed outside the United States. Including two tactical fighter squadrons in Alaska and support aircraft outside the 48 contiguous states, about 1,000 of the 2,500 tactical aircraft are deployed outside the CONUS. Within the United States, Tactical Air Command (TAC) has the responsibility for organizing, training, equipping, and maintaining tactical air forces. It operates 21 bases and has tenant units at 13 other Air Force bases, shown in Figure 35. Its eight upgrade training locations are circled in the figure.

TAC operations encompass all facets of the NAS. Its missions range from high-altitude navigation and aerial refueling to instrument and continuation training in terminal areas. TAC aircrews train for air-to-air combat and air-to-ground weapons delivery from both high and low altitudes. TAC missions are mostly conducted at high speeds in special-use airspace, fairly close to the home base because the range of tactical aircraft is relatively short. Training areas have to be close to home to avoid wasting costly fuel and flying time en route to and from training areas. Figure 36 shows a typical low-level training route.

In order to train with realism, local area training is enhanced by special programs and periodic exercises that add massing of forces and joint operations to training programs. The Red Flag program at Nellis AFB, Nevada, is the best example of realistic training; primarily for TAC forces, it includes other commands, services, and allies. A typical 6-day

FIGURE 35. Tactical Airlift Command's Flying Locations



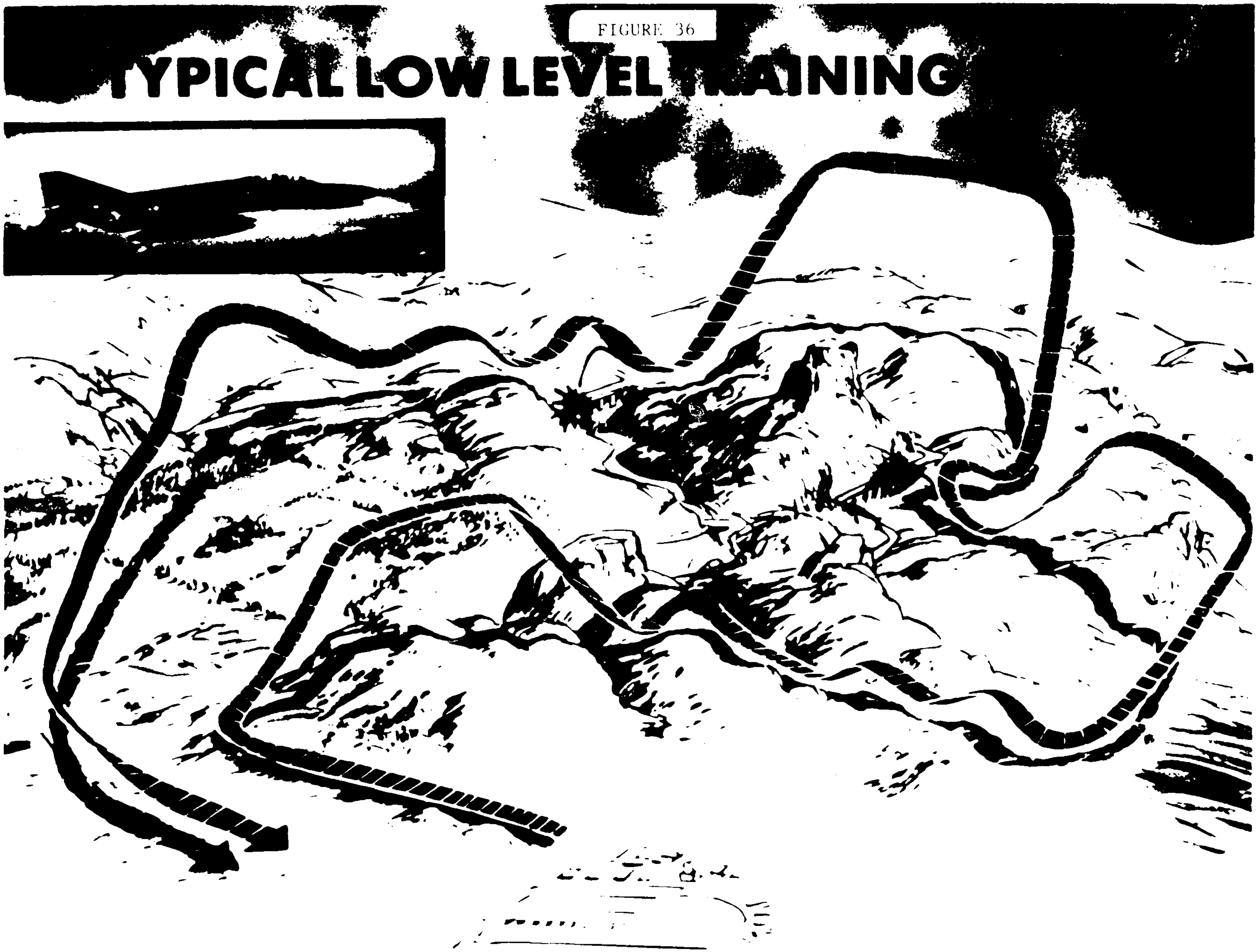


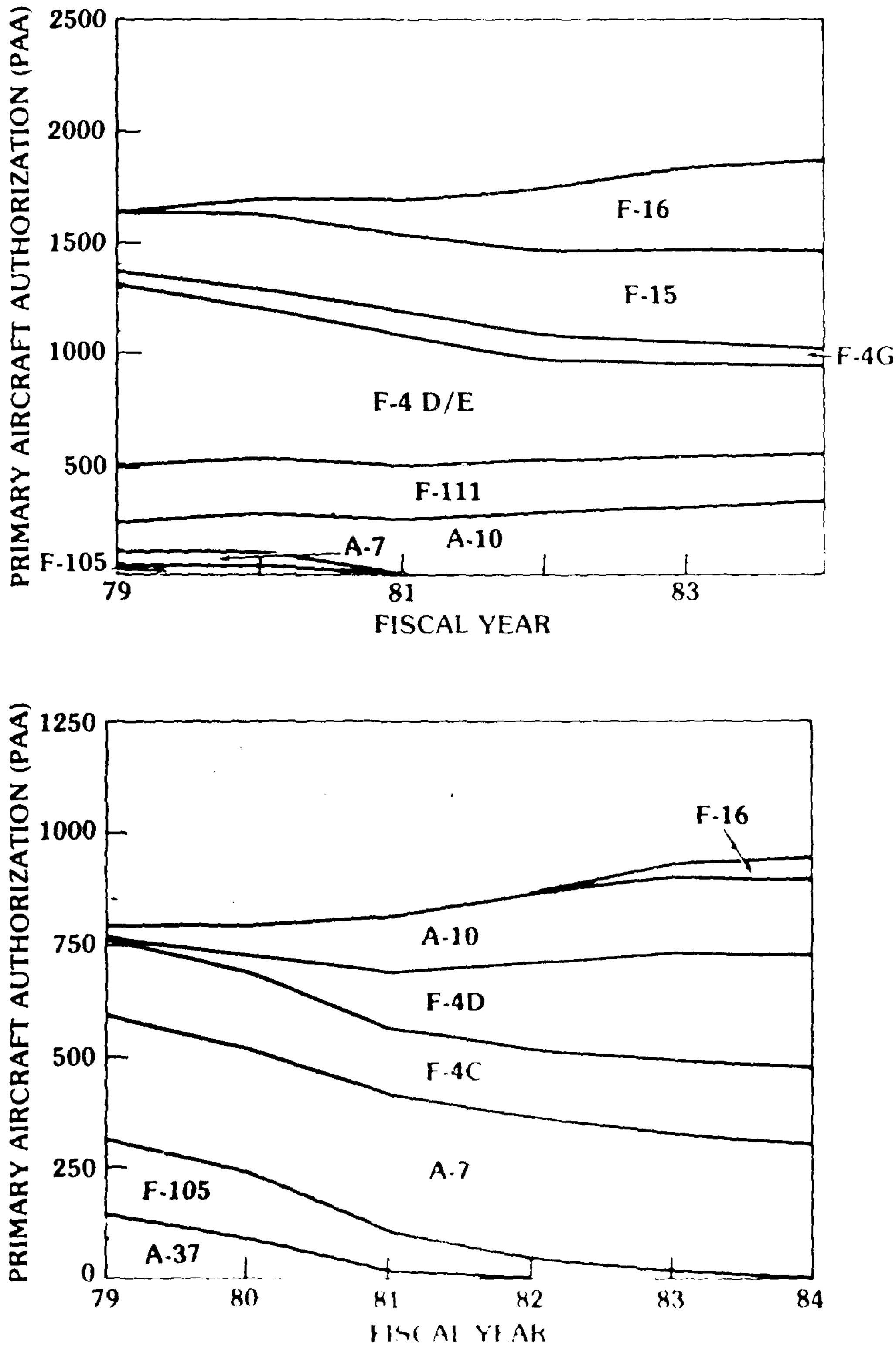
FIGURE 36

exercise involves up to 250 aircraft and 3,500 sorties.[35] The simulated threat includes aggressor aircraft (similar to Soviet aircraft) and antiaircraft, surface-to-air missiles, and electronic warfare simulations. Extensive as the Red Flag operation is, it provides only about 3 percent of TAC's flying needs.[36]

Tactical forces are to be expanded modestly in the future to meet the increased threat posed by the Warsaw Pact countries. The proposed defense plan provides over 4,800 fighter and attack aircraft for the Air Force.[37] The original purchase of 729 F-15s has been increased to 1,107 by Fiscal Year 1987. The F-16 procurement rate is at 120 per year, with a total goal near 1,400 aircraft. This program will probably last into the 1990s. Possibly more A-10 aircraft will be purchased. As these new aircraft enter the force, most of them will replace older aircraft and some of them will add to the force size. The replaced aircraft will in turn replace the older aircraft of the Air National Guard and the Air Force Reserve forces. Air Force fighter wings do not have their full complement of aircraft; there were 23.1 active wing equivalents in 1980. By 1986, there should be 26 fully equipped, active fighter wings and 14 Air Guard and Air Force Reserve wings, for a total of 40. Plans now could allow growth to 44 tactical air wings in the future. The tactical force structure through 1984 is demonstrated in Figure 37.[38]

Other forces to be purchased include air defense F-15s to replace aging F-106 interceptors and E-3A airborne warning and control system (AWACS) aircraft. The added AWACS will increase the present fleet of 25 to about 35. Five squadrons of F-15s will replace the F-106s in this country.

FIGURE 37. US Air Force Active Tactical Aircraft



Modest growth and rapid modernization are expected in tactical forces. The growth will generally be used to fill out units already in place. Additional emphasis will be placed on realistic training in large-scale joint operations. More practice in night and all-weather operations, as well as additional low level operations, is expected in the future.

Strategic Forces and Strategic Air Command

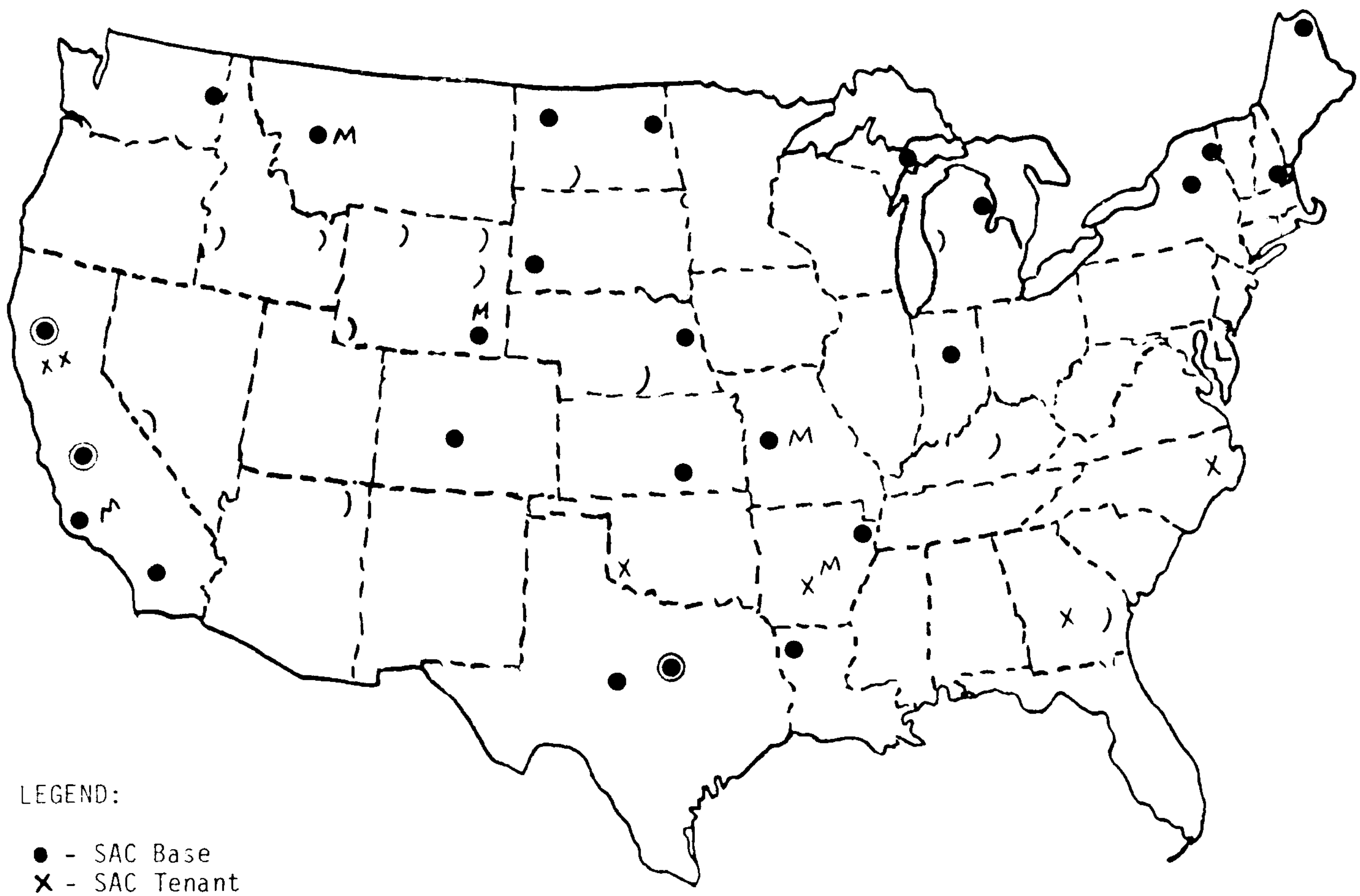
Strategic Air Command (SAC) forces consist mostly of bomber and tanker aircraft. There are some variants of the KC-135 that perform special missions, such as airborne command post and reconnaissance aircraft. SAC also has a few high-altitude reconnaissance aircraft. SAC has about 350 B-52s which include about 95 H models, 175 G models, and 80 older D models. It has about 60 FB-111s that operate from two locations in the Northeast. The tanker force includes about 600 KC-135 and KC-10 aircraft.

The nature of SAC's mission places unique demands on the air traffic control system. Its forces are widely dispersed. SAC operates 25 bases and has tenant units at 6 others. Six of the bases are primarily missile wings. In addition, some aircraft are deployed to PACAF and USAFE areas. The continental base locations are shown in Figure 38.

The aerial refueling mission for the tanker force takes place mostly in the high-altitude portion of the NAS. Tankers use the aerial refueling areas (already shown in Figure 29) to support strategic, airlift, and tactical training. Tanker missions seldom use airways for this practice, and they generally get special attention from FAA controllers.

The bomber missions are much more complex, as shown in Figure 39. They generally include both high- and low-level navigation and aerial refueling and low-level practice bombing, during which a hostile electronic

FIGURE 38. Strategic Air Command's locations



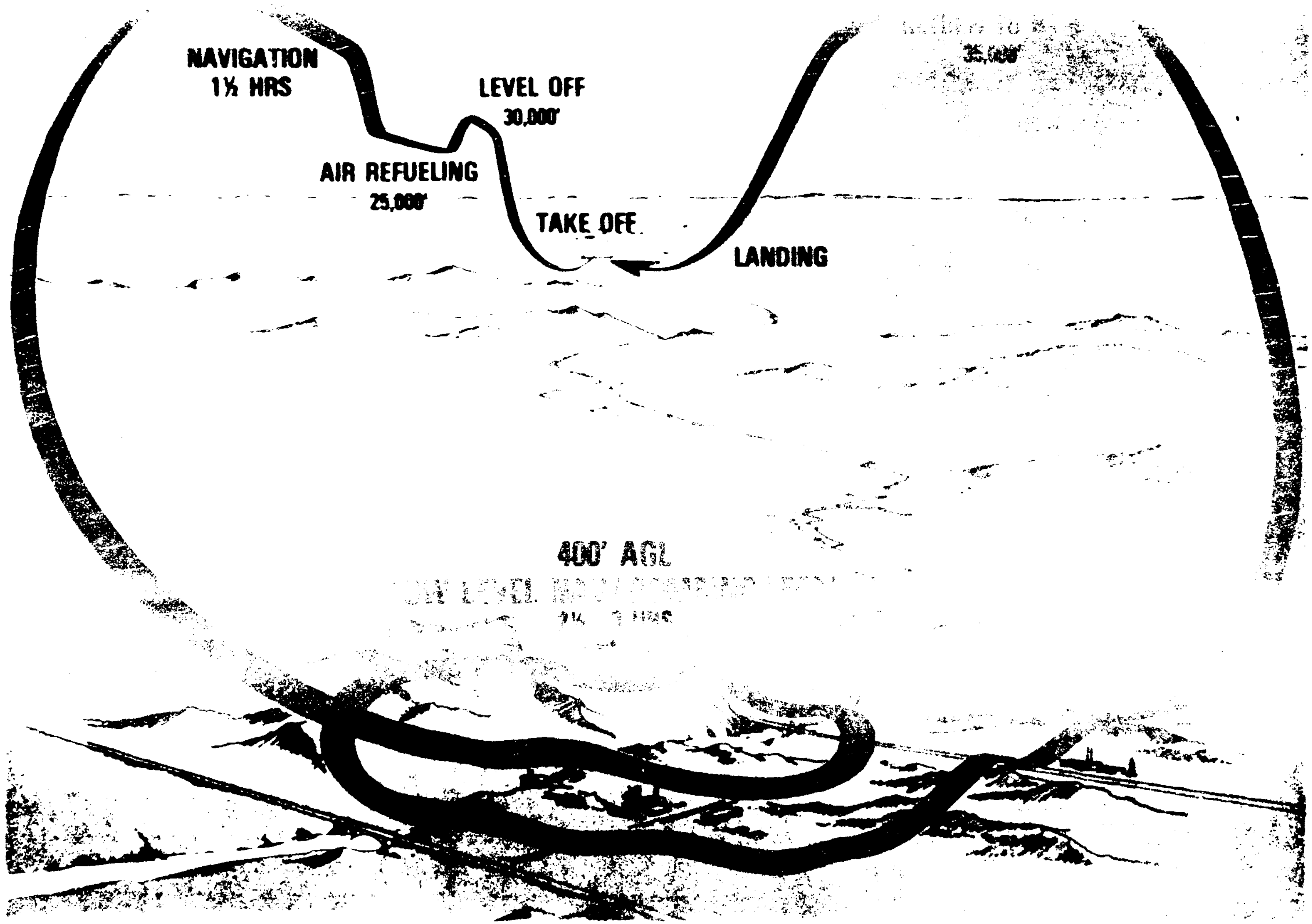
LEGEND:

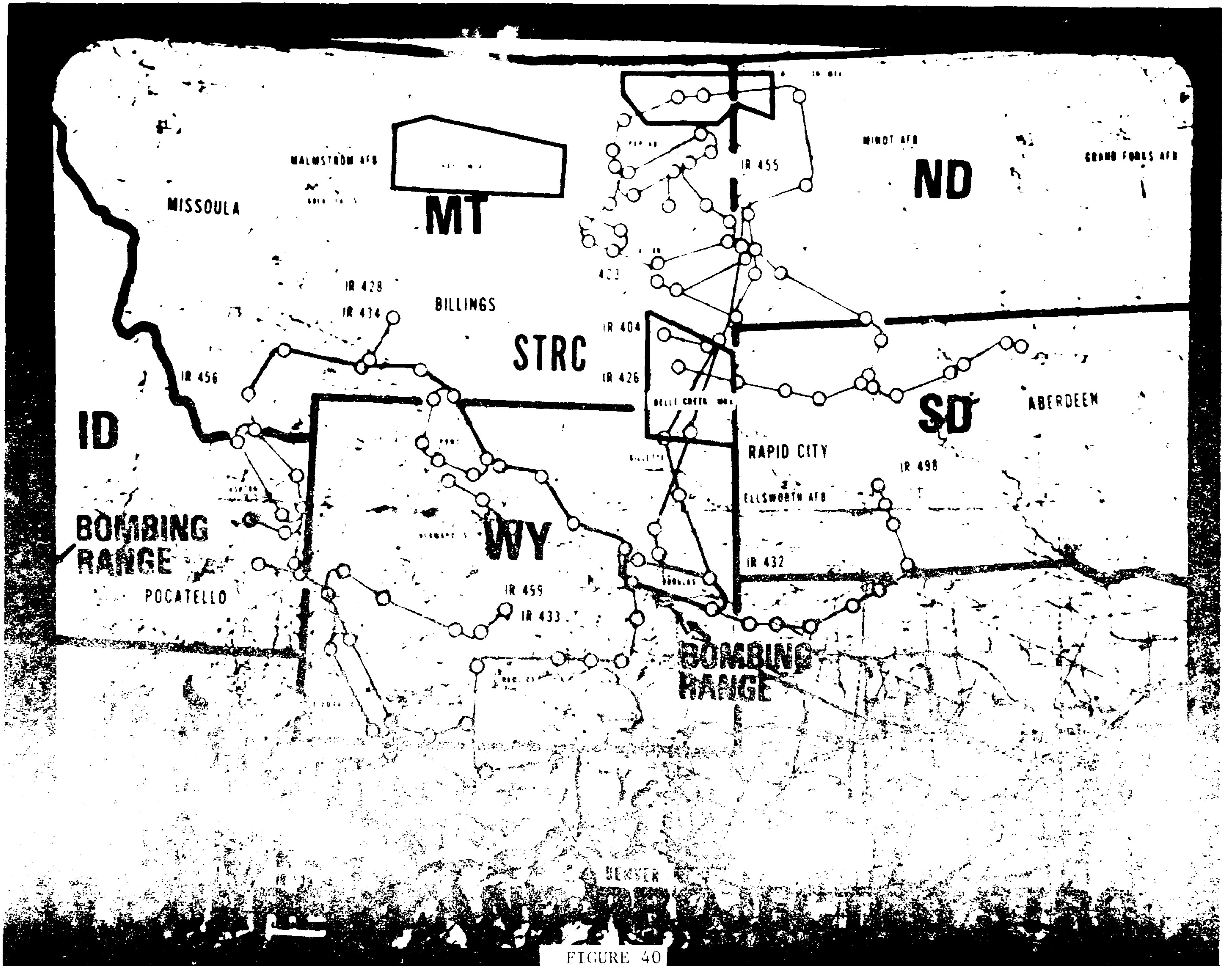
● - SAC Base
X - SAC Tenant
O - Training Location
M - Missile Base
) - Bomb Scoring Site

countermeasure environment is simulated. To support this practice bombing activity, there are now 16 SAC-operated radar bomb-scoring sites, each approached by military training routes (see Figure 38). The dispersed location of home bases and scoring sites dictate that nearly all FAA en route centers assist SAC aircrews.[39]

As the Air Force sought ways to increase training realism, a new concept for SAC training emerged--the Strategic Training Range Complex. This concept will enhance training realism and efficiency. Added benefits are reduced disruptions to civil aviation. This comes from the movement of about 15 percent of SAC's operations from the more crowded northeastern and southeastern sections of the country to the north central section. The current plan relocates six radar bomb-scoring sites into a training complex that occupies parts of Idaho, Utah, Montana, Wyoming, Colorado, North Dakota, South Dakota, and Nebraska (see Figure 40). The complex integrates MOAs, wider low-level military training routes, radar bomb-scoring sites, and live weapons ranges. It also includes a variety of terrain and vegetation necessary for realistic training.

This concept will affect SAC's follow-on training in a number of ways. It will provide a more realistic flying environment for training to meet the almost continuous threat that will exist. For example, fighter intercepts become possible. En route as well as low-level electric countermeasure activity will be added. The five weapons ranges will enable more complete exercise of aircraft weapons delivery systems with practice ordnance. The interconnecting route segments in the single complex will allow a wide variety of routes that will be scheduled by computer to avoid conflicts. This allows training on different routes to different targets


NAVIGATION
1½ HRS
LEVEL OFF
30,000'
AIR REFUELING
25,000'
TAKE OFF
LANDING
35,000'
400' AGL



MALMSTROM AFB
MINOT AFB
GRAND FORKS AFB
ND
MT
MISSOULA
IR 455
IR 428
IR 434
BILLINGS
IR 404
STRC
IR 426
IR 456
SD
ABERDEEN
ID
RAPID CITY
IR 498
ELLSWORTH AFB
BOMBING
RANGE
WY
IR 432
POCATELLO
IR 459
IR 433
BOMBING
RANGE
DENVER

FIGURE 40

with each flight rather than the current situation where aircrews fly the same route and attack the same simulated targets many times. This "first look" capability will certainly enhance training realism and effectiveness. As this program is implemented, SAC operations will continue at other locations since the new complex is expected to be able to support no more than 25 percent of SAC's flying needs.[40]

As far as the future of the SAC force structure is concerned, let us first look at the tanker force. The life of the KC-135 aircraft is to be extended beyond the year 2000 by replacing lower wing skins. This means that most of the force's engines must be replaced by more efficient, modern, new, or used 707 airliner engines. The force of 12 KC-10s could expand to as many as 60 since it supports both air refueling and mobility functions.[41]

The bomber force is scheduled to be modernized. First, the 270 newer B-52G and H models will be modified to carry cruise missiles and to make them more survivable. In 1986, the first of 100 B-1B bombers will become operational,[42] with all production models to be delivered by 1988. The advanced technology bomber will follow in the early 1990s. Initial plans call for about 150 of these aircraft.[43] As the force is modernized, old aircraft are to be retired. Some of the older B-52D models will be phased out in the near term. Some G models will be phased out in the late 1980s, and the FB-111s are scheduled to be phased out in the early 1990s.[44] Some of the B-52H models could be phased out in the mid-1990s.[45]

The utility of the manned bomber force in a conventional role was demonstrated in the Vietnam conflict and was recently demonstrated during

the joint Bright Star exercise in Egypt. This utility and the B-52's ability to function as a cruise missile carrier aircraft will assure its existence through the end of the century. New missions are developing for the B-52 because of its range and manned flexibility. Examples are the maritime role in the Indian Ocean sea-surveillance reconnaissance, and conventional applications supporting NATO and the Combined Forces Command in the Republic of Korea.[46]

Since no reduction in the threat is readily apparent, SAC forces will probably remain fairly static in size as their capabilities are enhanced with the cruise missile system. Possible future reductions in bomber force sizes will likely be offset by increased tanker force sizes. The high- and low-level mission requirements should remain well into the 1990s. Some movement in basing structure into the north central part of the country is possible. This will make more efficient use of the new range complex. This movement should make the strategic forces more survivable in the future.

Other Flying Activities

Air Force Logistics Command (AFLC) and Air Force Systems Command (AFSC) together operate 10 bases with flying activities. Also, AFSC has tenant units at two of AFLC's bases, as well as six other bases. While these commands do not account for major portions of Air Force flying activities, their base locations are fairly busy. The flying activities they conduct are special in that they are primarily concerned with flight test and aircraft and weapon systems development. This activity needs special-use airspace in most cases. Aeronautical Systems Division, with its 4950th Test Wing, is located at Wright-Patterson AFB, Ohio. Extensive testing

is done on ranges near Edwards AFB, California, and Eglin AFB, Florida. In addition, there is the Western Test Range, about 70 miles north of Vandenberg AFB, California, and the Eastern Test Range with launch sites at Patrick AFB, Florida. The Edwards Flight Test Center manages the Utah test and training range complex in northwest Utah.

The Air National Guard and the Air Force Reserve are a vital part of the total force. The purpose here is to describe the magnitude and location of their operations rather than the many ways these forces augment the active force. Their equipment and mission are representative of the active Air Force. Their airspace needs for realistic training are parallel to their active duty comrades-in-arms. An example, taken from a description of the Air National Guard by its director, is appropriate for all Air Reserve Forces. The statement was that Air Guard people, with their equipment, "can no longer be considered just 'weekend warriors,' but have evolved into a fulltime contingency force with worldwide missions."[47] Many examples could be given.

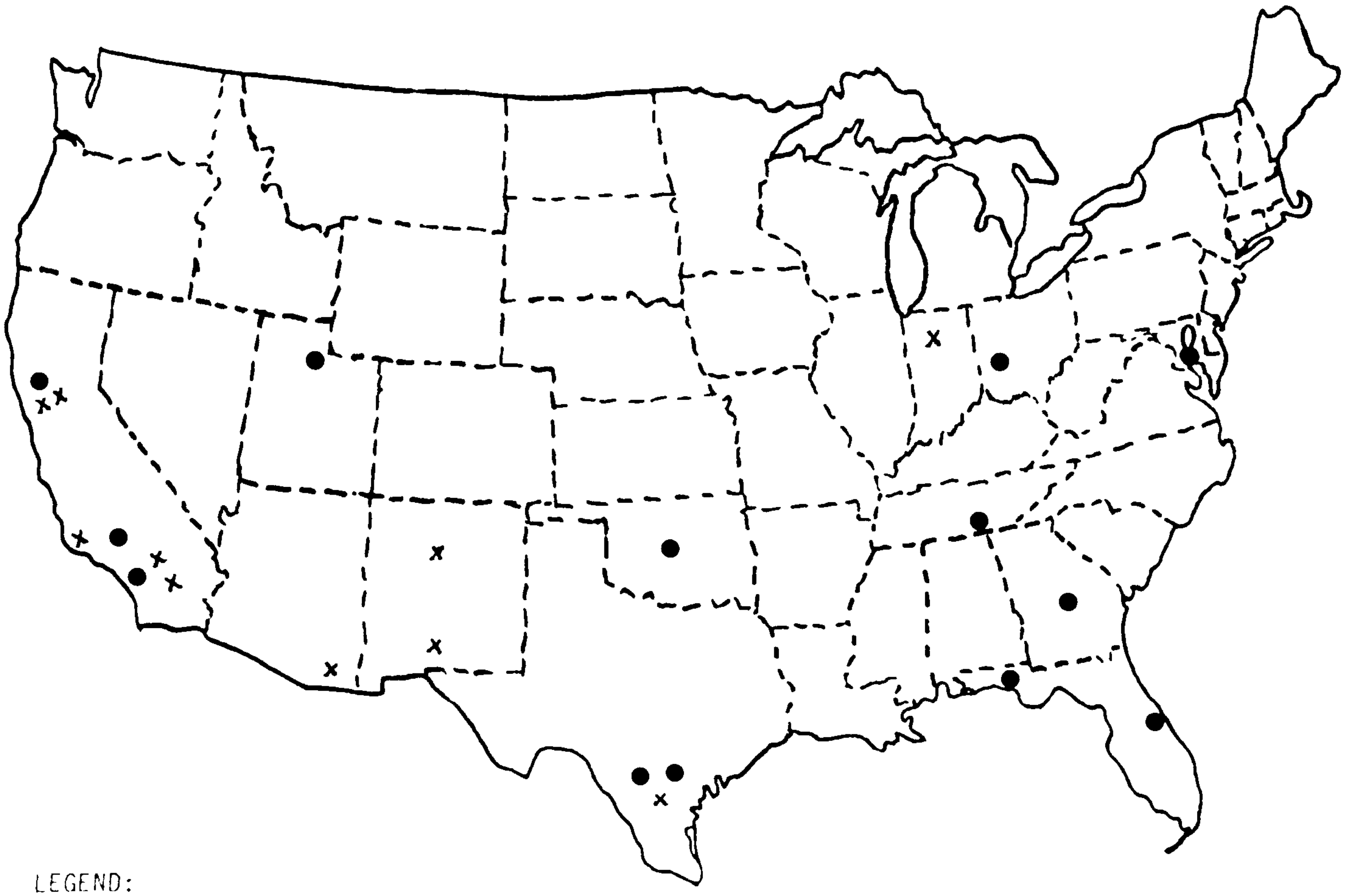
The Air Reserve Forces fly actively to contribute to the Air Force mission. Reserve aircrews and aircraft stand daily alert in KC-135 aircraft in support of SAC's deterrent mission. Reserve aircrews augment the K-10 and MAC's C-5 and C-141 crew force. Guard aircrews are on "air defense alert at 16 locations, 24 hours a day, 7 days a week, 365 days a year."[48]

The Air National Guard has about 18 percent of the total Air Force active and Reserve aircraft (about 1,650) and annually flies about 12 percent of the total flying hours. Only about 20 percent of its aircraft are cargo or transport types which have higher utilization rates due to

longer length of the average sortie. This is one reason why the percentage of flying time is smaller than the percentage of aircraft possessed. The Air Force Reserve has about 5 percent of the total active and reserve aircraft (about 455) and flies about 4 percent of the annual flying hours. In the mid-1980s, some change in the Air Reserve force size is expected. As active units get modern aircraft, the Reserve force will get newer, replacement aircraft. In some cases, they will even get new model aircraft. The first goal is modernization of the force. By 1986, the goal is to increase Reserve tactical forces to 14 wings, which would be an increase of over 10 percent.[49]

The Reserve force operates out of over 125 locations. Many of these locations are on active duty bases or civilian fields, and many have been shown in preceding figures. Air Force Reserve units operate from 23 Air Force bases, 2 Naval air stations, 2 Air National Guard bases, 3 Air Force Reserve bases, and 7 private fields. Five of the private fields have Reserve bases located with them. The Air National Guard flying units are located at over 60 civilian fields, 3 Naval air stations, 12 active and Reserve Air Force bases, and 9 Air National Guard bases (3 of which use civilian airfields). Figures 41 through 43 show the locations of the AFLC, AFSC, Air Force Reserve, and Air National Guard flying units. The Air Force Academy is also shown because it has some unique airspace requirements which include flight screening, glider, and parachute operations.

FIGURE 41. AFLC and AFSC Locations



LEGEND:

● - AFLC and AFSC Bases
X - Tenant Unit

Figure 42. Air Force Reserve Units

Figure 43. Air National Guard Flying Units and Physical Locations

In summary, military operations are diverse and will continue to be so in the future. They will continue to need special service and airspace within the NAS. To enhance readiness, the future trends will be for more realistic training, slight force expansion, and slightly increased flying per pilot. The additional flying is necessary to prepare the force to respond immediately. Most new aircraft will replace older aircraft, and the current structure will be brought up to strength. Total force strength will be increased in the 10 percent range. In addition to more training, the type of training will change somewhat. Training realism will dictate more low-altitude practice and all-weather flying. Increased air refueling practice for all Air Force missions will be evident.

The operations of the other military services will not be a great concern to ATC planners. The other military services will follow the same growth and quality of training trends as the Air Force. Force modernization will occur with slight growth. However, the Army's operations will continue to be at altitudes below where most command flying is done. The maritime forces operate mostly from coastal locations; thus, they will generally not concern command planners.

Major competition will come specifically from the Navy's initial flight training programs. In general, the airspace for low-level flying and air-refueling training will be more in demand. Also, SAC will probably move some forces more towards central states to make more efficient use of the new strategic training complex.

CHAPTER IV

FUTURE STRUCTURE AND AIRSPACE REQUIREMENTS OF AIR TRAINING COMMAND

This chapter begins with a brief overview of ATC's current flying activities. It then discusses future changes in structure and airspace requirements.

Air Training Command is the largest training-education complex in the free world.[1] A large part of its resources are used in the recruiting, basic training, technical training, and initial flying training functions. In fact, ATC's involvement extends from the recruitment of personnel, through their initial training, to professional military education and follow-on training programs later in their careers.

Current Flying Activities

The broad scope of the command's flying activities covers flying training from screening programs through advanced training programs. The command trains Air Force as well as foreign pilots and navigators. Navy and Marine navigators are also trained in ATC's programs. ATC logs over 20 percent of the Air Force's flying hours, second only to MAC in total flight hours logged in 1980 by a major command. The command operates over 1,500 aircraft, which approaches the number of Air National Guard aircraft and which is over three times the number flown by the Air Force Reserve.

Current Programs and Locations

ATC's UPT program should not be compared to civilian student pilot or airline pilot training programs. The ATC program is designed to teach students to fly who have no previous flying experience (unlike the

airlines). It teaches basic skills as well as more advanced maneuvers. The skills learned are applied to using an aircraft as a part of a weapons delivery system--a far cry from "driving" an airliner around. Even pilots destined for multiengine (large) aircraft need to be taught skills, such as formation flying skills that are used when leading in a tanker or following in a receiver during air refueling. The low-level and weapons delivery-type tactics used in many large aircraft are very similar to those used by smaller fighter aircraft. No matter which aircraft an Air Force pilot will fly, the training must prepare him or her for highly technical, sophisticated aircraft and equipment operations. The military pilot must fly the aircraft by reflex, with primary thoughts given to accomplishing a war-fighting mission. Navigators must learn to do a lot more than navigate. They can often become weapon systems and/or defensive systems operators aboard aircraft with a combat mission.

The command has many different undergraduate and graduate flying training programs. Less known courses include formation lead-in training, advanced and tactical navigation, electronic warfare training, and medical officer flight familiarization. The navigation-related courses are consolidated at Mather AFB, California, while most others are conducted at Randolph AFB, Texas. In addition, ATC trains instructor pilots to support pilot and navigator training programs. This training occurs at three locations: Randolph AFB, Texas, for UPT; Mather AFB, California, for navigator training; and Sheppard AFB, Texas, for Euro-NATO Joint Jet Pilot Training (ENJJPT).

ENJJPT is a complete, joint UPT program for NATO forces, conducted at Sheppard AFB, Texas. This program, which includes an instructor

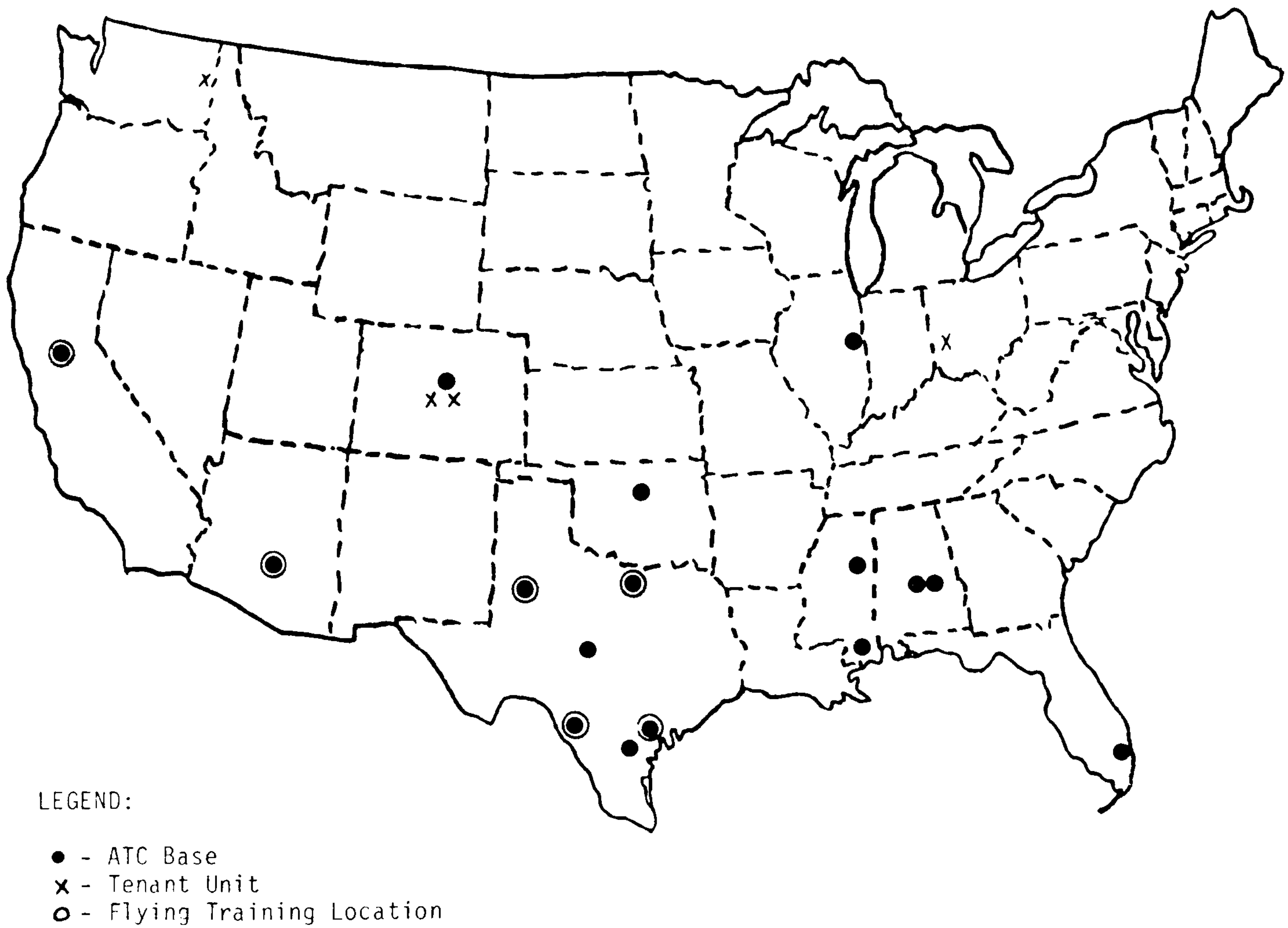
training course, is primarily designed to train fighter pilots. Forty to 50 percent of the course graduates are USAF personnel.

ATC operates 15 installations, shown in Figure 44. The primary flying training locations are circled. UPT is conducted at Columbus AFB, Mississippi; Laughlin AFB and Reese AFB, Texas; Vance AFB, Oklahoma; and Williams AFB, Arizona. Tenant units also fly from Keesler AFB, Mississippi, and from Maxwell AFB, Alabama.

Unless they already have a pilot's license, pilot training candidates participate in a screening program that uses light aircraft. Reserve Officers' Training Corps (ROTC) pilot candidates attend a light aircraft flight instruction program operated under civilian contract near their schools. Officer training school prospects go to the flight screening program at Hondo AFB, Texas. These screening programs include about 15 hours of preliminary flight instruction and are used to determine a student's aptitude for pilot training. Air Force Academy cadets attend the pilot indoctrination program at the Academy near Colorado Springs, Colorado, which has just over 20 hours of flight instruction. One of its goals is to screen students for pilot aptitudes. If a student is deemed qualified when completing a screening program or already has a pilot's license, he or she then attends Air Force UPT.

The UPT program is made up of three training phases which combine academic training and officer development.[2] Academic training covers such subjects as aerospace physiology, T-37 and T-38 aircraft systems operation, aerodynamics, instrument training, aircraft performance computations, flight planning, navigation, aircraft accident prevention, and weather. These academic courses total about 267 hours of classroom and laboratory

FIGURE 44. Air Training Command's Locations



instruction.[3] About 140 hours of training are devoted to officer development: officer orientation and processing, physical training, career counseling, moral leadership, and traffic safety education.[4]

The preflight phase is the first of the three phases of training. This phase covers learning objectives required prior to flying an airplane. These learning objectives prepare students for the last two flying training phases to the maximum extent practicable. Items taught include ground and flight training policies and procedures. The student learns what is expected of him or her in order to complete the flying training course. Also, the student masters subjects that are prerequisites for flying; these include ejection seat training, emergency procedures, flying rules, and communications requirements.[5]

The final two phases of training are the flying phases, which comprise the majority of the 49-week course. The flying phases last 45 weeks, depending on the class start date. There are eight classes spaced throughout the year, with classes that fly mostly in good weather months scheduled for a shorter time period in which to complete their course. Weather is an important factor in determining how smoothly the command's operation can be run.

The current UPT course has evolved and has been refined since 1947.[6] All students first fly the T-37 in primary training and then the T-38 in basic training. The course is developed with the cooperation of the Air Staff and the major commands that use the pilot graduates. Their representatives meet periodically to define what skill and knowledge levels are required of UPT graduates. The skill and knowledge levels are converted to job tasks, with specific parameters and standards defining

the course training standards. The syllabus of instruction is developed to insure that course training standards are met. It specifies sorties, training hours, and lessons programmed to train a student.[7]

Primary flying skills are taught and evaluated during the initial phase of flying training in the T-37 aircraft. The T-37 is a subsonic jet trainer. The syllabus programs the students to fly 57 sorties and 74.4 hours in this phase, including 12.4 hours of student solo time. Students are also scheduled to receive 28 sorties and 35.5 hours in a modern simulator or cockpit trainer in addition to the academic training already discussed.

In the final phase of training, students transition into the T-38--a high-performance, supersonic jet trainer. Whereas the primary emphasis in the T-37 was beginning visual and instrument flying skills, in the T-38 the major emphasis shifts to formation flying and navigation. This phase includes 101 hours of flying time which is 80 sorties. Twenty-six to 30 flying hours are student solo. Also, 29 sorties for 36.8 training hours of simulator flying time and trainer time are added. In order to complete the course and be awarded pilot wings, students must meet all course training standards.[8]

This program has been known as generalized UPT since all students, regardless of follow-on assignment, train in the same type aircraft using essentially the same syllabus. Some specialized tracking, or course specialization, has been added recently in order to increase training effectiveness and to enhance graduate quality. As students near course completion, an Advanced Training Recommendation Board (ATRB) is convened to identify students as fighter/attack/reconnaissance (FAR) qualified or tanker/

transport/bomber (TTB) qualified.[9] The student pilot's follow-on assignments are based on three factors: the needs of the Air Force, the recommendations of training supervisors (ATRB), and the individual's desires. The recommendations of the ATRB and a statement of student preference are forwarded to the Air Force Manpower and Personnel Center where assignments are made to satisfy the needs of the Air Force.[10]

As soon as the ATRB results are known, student pilots begin receiving some specialized training. Essentially, pilots destined for FAR assignments concentrate on formation and visual maneuver training, while those students destined for TTB assignments receive more instrument practice in lieu of the formation training. This amounts to about 5 hours of the scheduled flying training.[11]

Command Uniqueness

The uniqueness of the ATC's flying operation affects its requirement for airspace. The command has inexperienced student pilots on nearly every sortie flown. (Some instructor proficiency training does occur.) About one-fourth of all sorties flown from UPT bases are by solo student pilots in relatively high-performance aircraft in a very busy environment. Most of the remaining sorties are flown in this environment with a student and instructor involved in a teaching process. Thus, attention given to just flying the aircraft is divided between student and instructor. However, inexperienced students do most of the flying in such cases. This leads to some inefficiency in the actual aircraft operation, particularly in earlier stages of training, but is necessary for an effective training process. If an instructor never allowed a student to make a

mistake, the student probably would not develop the necessary judgment expected by the end of the training program. Within the limits of flying safety, students have to be allowed to err or to operate inefficiently; they learn by their mistakes. For example, students are expected to fly to an area and to stay within a particular bounded parcel of airspace. If the student is warned by the instructor or a radar controller every time the aircraft approaches a boundary, he or she becomes dependent upon this help.

As mentioned, the flying environment around a pilot training base is "busy." This is probably an understatement. Assuming about 440 student pilots will graduate at each base this year, with a minimum of 137 sorties apiece, the result is over 60,000 sorties per base for graduating students. In addition, few sorties are flown away from the home base for navigation training (about 7 percent). The sorties flown by students who do not pass the course and the added flying for instructor proficiency and check flights must also be added (about 19 percent). This adds up to about 67,000 sorties per year generated by each base. With a 216-flying-day schedule, that is over 300 sorties each flying day. Since multiple landings and approaches are made on each sortie, the activity (operations' count) at these bases is very high. Assuming three departures or takeoffs for each UPT sortie and that two-thirds are made at the home field, each UPT base will have about 135,000 departures this year. This amount compares to many of the largest civil traffic hubs. In 1979, Stapleton International at Denver, Colorado, had 148,000 departures; San Francisco International had 120,000 departures; Washington National had 104,000 departures. UPT bases are busier than most civilian fields. When flying weather is good, there is nearly a continuous flow of air traffic at all three runways.

Also, the command's uniqueness comes from the fact that most of its flying activity has to be done on weekdays during daylight hours. Good weather is also needed for student training. Even though the flying schedule includes flexibility for poor weather, each base's flying resources are severely taxed to keep up, or to catch up, with its pilot production schedules when sustained bad weather occurs.

Another unique factor is the types of aircraft used in ATC. The relatively short range of the T-37 and T-38 compounds the effect of marginal weather. They cannot be flown in such weather because the aircraft cannot reach a suitable landing field if the weather becomes too bad to land after they take off. In addition, the T-38 cannot be flown on days when engine ice could develop. The limited range of these aircraft also makes it necessary for most training to be done as close to the home base as possible. Hence, ATC's airspace requirements are unique.

The MOA and ATCAA designs are unique for each base. The proximity of civilian fields and routes as well as the needs of each base--including the location of its auxiliary field--are taken into consideration. The auxiliary field is usually used for T-37 pattern and landing practice. The letters of agreement coordinated between the applicable FAA facilities and each base specify MOA boundaries, routing, and procedures for operating in the MOAs. This determines the unique service the FAA will provide at each base.

Ideally, MOAs are positioned clear of any other controlled airspace, such as airways, and are as close as possible to the base. T-37 areas are normally within 60 miles, and T-38 areas are normally within 100 miles of their bases. The MOAs are divided into segments of at least 100 square

miles for T-37s and 200 square miles for T-38s. Segment sizes vary since different type missions require different allotments of airspace. For example, a formation mission would need a larger area than a single ship sortie. The vertical limits vary for each segment. T-37s require smaller altitude increments than T-38s. MOAs and letters of agreement may be redefined to keep pace with the rapidly changing NAS environment.

The UPT program--in fact most of the ATC's flying operation--is strictly under radar control. This conforms with Air Force policy and enhances flying safety. From takeoff to return to home base, each aircraft sortie is almost continuously controlled and monitored by controllers using radar. The controllers may work in a military or civilian approach-and-departure control or an FAA en route center.

Future Flying Activities

Having completed an overview of the current system, we can now discuss anticipated changes to ATC's programs. These changes range from planned program and equipment changes to possible modifications of training philosophy.

Special-Use Airspace Design

Up to this point, the reader should have a general idea of the airspace structure and operational environment around a UPT base. The operation has been aptly described as resembling a "beehive."[12] Each base and local area is unique. This is the reason the physical design of each MOA has to be done by local Air Force and FAA representatives. The MOA design must incorporate a sufficient volume of airspace to support each base when the maximum student load is present and to prevent airspace from

becoming a limiting factor in base student production capacity. When airspace is not needed, it is used without restriction by all civil and military users. However, when airspace is needed, it must be readily available for base use.

The airspace for instrument practice must be included in a base's airspace requirements. Even though a great deal of instrument training is done in simulators (about 75 percent of scheduled instrument sorties), there is a requirement for maneuver, en route penetration. and instrument approach practice in the aircraft. Added instrument flying practice is done by students during many navigation missions.[13] Students must get high-quality instrument training time in the aircraft to become military pilots who are safe, proficient, and capable in all types of weather. Therefore, instrument training facilities are included, when possible, within MOA areas. These facilities should include navigation aids, terminal approach aids and procedures, and necessary controller support.

Another important consideration in designing an MOA is the avoidance of a conflict with nearby military and civilian fields. Heavily used traffic lanes should also be avoided; in fact, it is best if no low- or high-altitude airways go through the MOA. MOA design should allow for simplified approach and departure routing. The high activity levels around UPT bases make procedurized departure and arrival routing mandatory. Some procedures are good because they add to student task loading and enhance training, but too many reduce a student's ability to use and to develop initiative and judgment. These two qualities, though hard to quantify, may well be the most important objectives of the UPT program.

Future Pilot Training Programs and Airspace Impacts

Since this study is a planning effort, the future ATC program structure and airspace requirements are of primary importance. Therefore, the remainder of this chapter is devoted to describing planned changes to the command's training programs and training requirements and their impact on airspace requirements.

The command's aircraft are approaching the end of their design life. Attrition losses and increasing training requirements are making the number of airframes possessed the limiting factor to the command's training capability. This capability is rapidly approaching the point where too few airframes are available to train the number of pilots needed, given the course requirements generated by the current generalized UPT program.

As early as 1971, analyses of future UPT training requirements were being made because of anticipated shortages in the number of airplanes available to meet pilot production requirements.[14] The idea of specialized training was <u>re</u>introduced at that time. During a study of specialized UPT in 1976, ATC personnel concluded that generalized UPT should continue, although the efficiencies of specialized training were acknowledged. At that time, the rationale was as follows.

> [T]he purchase of a new aircraft to support specialized training cannot be justified in view of today's [1976] austere budget, programmed low production and the resulting fleet-life extension this affords, and MAJCOM acceptance of the current, high-quality UPT graduate.[15]

Further concern about future pilot training capabilities by top Air Force officials generated another ATC study which was completed in April 1977. This study concluded: "The most effective pilot training system, both in terms of graduate quality and economic considerations,

to replace the current [generalized] system is a specialized UPT system. . . ."[16] But declining pilot production rates through 1979 and budgetary constraints delayed the final decision to implement specialized UPT (SUPT) until June 1980. The Secretary of the Air Force and the Air Force Chief of Staff approved the concept at that time.[17]

Currently, ATC personnel are progressing toward implementation of SUPT. Implementation is planned for the late 1980s and is dependent upon funding for a multiengine trainer aircraft to be used with the TTB track. There are several off-the-shelf multiengine jets that could be used in the TTB training program in a size class similar to the T-39. Most likely, a lease option will be used to acquire the number of aircraft required, which would initially be about 200.[18]

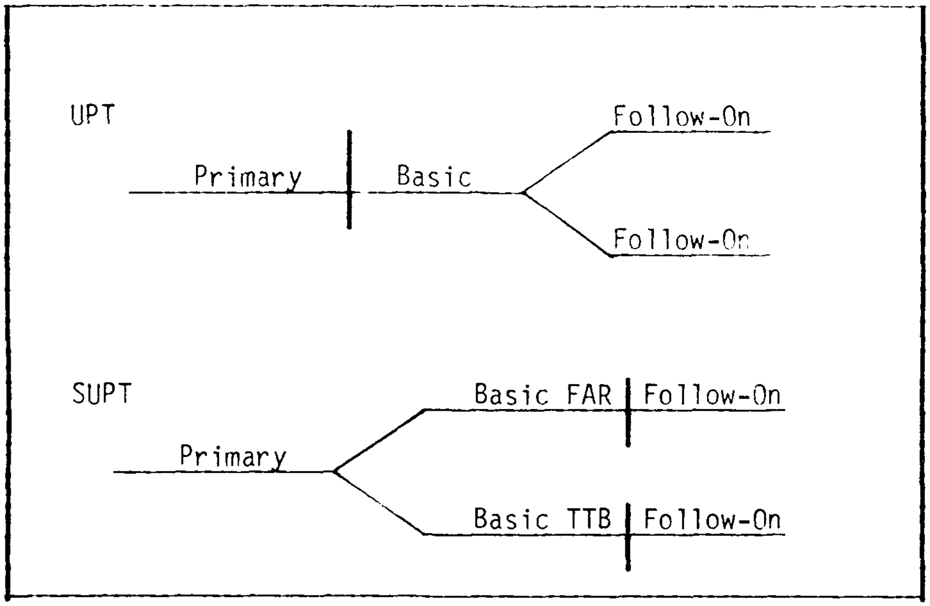
The specialized program will be a two-phased program with a common primary training phase for both FAR and TTB tracks. The preflight phase used in generalized UPT will be included in the SUPT primary phase. All students will take the same primary phase; near the end of the phase, follow-on track selections will be made under similar constraints used in generalized UPT for follow-on assignment selection.

The syllabus for SUPT has not been finalized; however, some basic planning factors have been established. The common primary phase will be about 54 flying sorties and 85 flight hours, including 13.7 solo hours. Thus, the SUPT primary phase adds 10 more flying hours to include more formation and low-level navigation training which are necessary to permit a thorough evaluation of student potential for the track selection process.[19] Added formation training increases airspace sector size requirements, and added low-level navigation may require more low-level

routes. Since the sortie length and launch interval remain the same in the SUPT primary, the same number of primary sorties can be airborne at one time as is the case today. Therefore, slight increases in maximum airspace requirements may become necessary. Also, for an equal number of student production, a slight increase in daily sortie requirements (about 5 percent) will result for the SUPT because of the course length change. A slightly smaller proportion of airborne sorties will be student solo. The major impact of the increased primary length will be a reduced primary training capacity; however, there should still be adequate primary training capacity in the system. All five pilot training bases will conduct the primary course.

After the primary phase, the student pilot goes on to the selected basic phase of training. This is where specialized training begins. The FAR track student will fly 87 sorties and 107 hours in the T-38.[20] This adds seven sorties and six hours to the current syllabus. A slightly shorter average sortie length is planned for the SUPT FAR syllabus, which amounts to a reduction of only about 2 to 3 percent (or 2 minutes per sortie). The effect of this should be negligible on airspace requirements. However, the increased total flying hours, coupled with a shorter phase length, will tend to cause average airspace usage per student to rise on the order of 5 percent. That is, for a given number of FAR graduates, SUPT will use a little more airspace than the generalized program.

FIGURE 45. Comparison of UPT with SUPT



Another factor affecting each base's airspace needs is the distribution of the student loads at the pilot training bases. With generalized UPT, the workload was spread fairly evenly across all five bases, based on many factors but determined primarily by the weather pattern. A base with a history of fewer lost sorties to poor weather has slightly larger training loads. In the SUPT program, only Williams AFB, Arizona, and Laughlin AFB, Texas, are scheduled to have the FAR basic track. Thus, depending upon the training requirement by track (the distribution of pilot assignments to FAR or TTB aircraft), the FAR base's training load may not balance with the TTB bases. The result could be uneven distribution of airspace requirements, which is not necessarily a problem.

To illustrate the complexity of the issue, consider just the two FAR bases. Williams AFB has much better weather than Laughlin AFB. Yet, other traffic in the flying area and tenant operations at Williams AFB cause

severe competition for airspace and controller services in that area. Laughlin AFB is relatively free from competition for airspace. Maintenance and support capabilities at each base also have to be considered. So, in order to balance workloads between the bases, many diverse factors have to be taken into consideration. Airspace is less of a problem at Laughlin AFB than the weather; the opposite is true at Williams AFB.

The TTB track of the SUPT will use a different aircraft, but the training objectives are nearly the same as the FAR track. Specialization comes from a few specific changes between the tracks. The TTB track does not include aerobatic, advanced, single-ship maneuvers, and some of the subareas in formation training. In the formation requirements, the TTB track adds trail formation and minimum interval takeoff not present in the FAR track. The specialized training only in the TTB track is air drop fundamentals and inertial navigation system training. Also new to both tracks is airborne rendezvous and air refueling formation.[21]

The system's operational concept gives a range of sortie requirements for the TTB basic phase of training. The higher end of this range is most relevant and will probably be the starting requirement. Recent major using command validations of future training requirements and further syllabus development have indicated the need for more training. Further program refinements are sure to be made. Even though the TTB student has the advantage of being a dynamic observer on 51 sorties, he still requires a great deal of hands-on training to meet course training standards. The syllabus outline calls for 69 sorties and 112.5 flying hours, 30 of these hours occur during 18 team sorties (2 students with no instructor aboard). In fact, most flights will last about 3 hours, with each student

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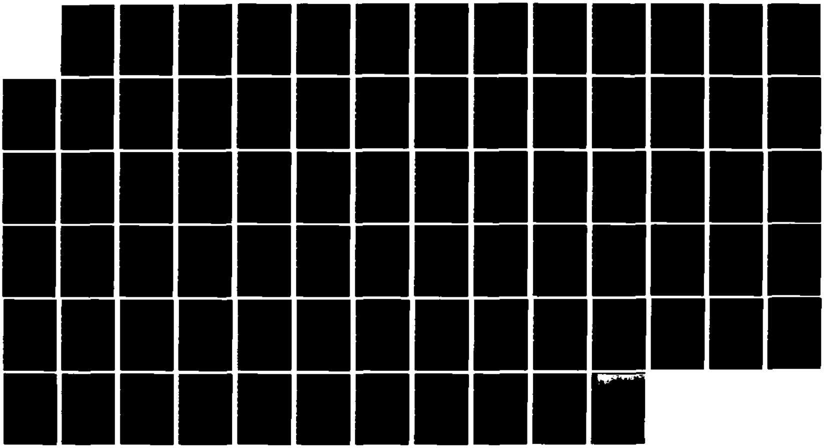

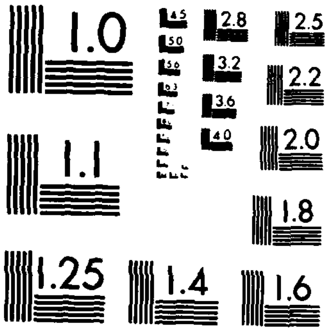

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primary crew seat 1.5 hours during the flight. The navigation sorties are scheduled for 4 hours, with the students alternating seats, during 2-hour legs when possible. Thus, the student's average sortie length is about 1.6 hours, and flight lengths are between 3 and 4 hours.[22] Also included in the program are 39 sorties and 50.7 hours of cockpit trainer and simulator time.

A brief review of program training goals is pertinent here. The TTB track needs to be rigorous since the program graduate needs to be of first pilot (not co-pilot) quality. Even if the military pilot begins as a co-pilot, "he frequently exercises skills, knowledge, judgment and techniques expected of first pilots."[23] The commercial pilot is drawn from a different experience base, often beginning with the airlines with a commercial and instrument rating and a vast amount of flying experience. Even then, the commercial pilot may spend up to 15 years or more as flight engineer and co-pilot before becoming the pilot in command. In contrast, the TTB pilot graduate will move directly to co-pilot duties and will most likely upgrade to pilot in command with 1,000 to 1,500 flying hours (during his or her first tour after UPT). In addition, the military mission is much more complex; do not forget that the military student pilot has probably started training in the Air Force without ever having flown an aircraft before.[24]

What training is therefore required and what are the impacts on airspace requirements? The effectiveness of specialized training will come from the specific maneuver tasks and procedures student pilots will receive. Major questions are: How much of the current T-38 airspace will be needed or can be used in the TTB track? What restructuring will be required? What new airspace and controller services will be required?

The structure of base flying areas will have to be determined at each base, depending on factors previously discussed. The fact that two students will be on each flight and that each flight will be much longer will have impact on the airspace requirement. Given the smooth-flow launch interval (3 minutes) used in ATC, the longer sortie length will allow many more aircraft to be airborne at once. For example, the T-38 average sortie length is about 1 hour, 15 minutes. This would allow 25 missions to be airborne at once. On local area flights of 3-hour duration, 60 TTB aircraft could become airborne. This will greatly enhance the catchup capability after periods of poor weather.

In addition, periods of poor weather will have less impact on the TTB track operation. The aircraft will lose fewer sorties because of its greater ranges which gives it the ability to fly out of the local area or to get to more alternates from the local area. The result is that somewhat less local area airspace may be needed.

When compared to the current system, the TTB track generates fewer sorties and flying hours in the local area for an equal number of students. Only 97.5 airframe hours and 60 sorties are required since the solo (team) sorties have two students aboard. The track's increased navigation training time will also take students out of the local area. In addition, it seems beneficial for students to get some experience on actual air refueling tracks, on published low-level bombing routes, and possibly in actual drop zones for their specialized training. All this would have to be balanced with a maximum use of local flying areas from the standpoint of efficient training. This means creating or simulating these special-use areas in the local MOA. The closer the training is done to home, the more

efficient the operation becomes. At the same time, students receive great training benefits by seeing diverse situations during their training. Good examples are strange field landings and different instrument approaches. There must be a proper balance between doing as much as possible close to home yet getting away enough to get diversified training.

Because of the absence of aerobatics and special maneuvering in the TTB track, the current T-38 airspace can probably be stratified, thus enabling more aircraft to use it. Also, it may be necessary to restructure existing MOAs somewhat to provide for long enough airspace parcels to build air refueling tracks that will use airspace slightly farther from the home base. Since aircrew attention is focused on the aircraft involved during air refueling training, restricted airspace near the home base may be required. Also, maneuver airspace will need to be retained to perform the maximum performance maneuvers in the TTB program.

It is very difficult to make specific suggestions until more is known about the program design and the aircraft to be used. The program is sure to be refined even after initial implementation. For example, the current plans for formation training in the TTB track include only minimum interval takeoff, air refueling formation in the precontact position, and cell formation.[25] (Note: There is also formation training in the primary phase.) It could well be determined that the skills and judgment learned in a more complete formation training program are needed to operate multiengine aircraft in the operational environment. This applies to air refueling activities as well as to general flying skills. The skills learned in formation training tend to smooth the pilot's flying technique as well as enhance the student's judgment and initiative.

In addition, the command's last experience with a multiengine track was in 1959. The flying environment in the using commands has changed quite a lot since then. The air refueling requirements have greatly increased as have low-level tactical flying requirements. Aircraft systems are much more sophisticated. The relative experience in the crew force has declined so that pilots upgrade with less experience, and there is less experience in the unit to help the new pilots' progress. Hence, it is reasonable to expect that modifications to the original program will be required.

T-37 Replacement Trainer

The studies that led back into the specialized training concept were initiated by concern over future insufficiency of the aging T-37. Parallel work during the same time period has resulted in a program to replace the T-37. This replacement aircraft is known as the next generation trainer (NGT) that is now planned to become available just before the SUPT program starts. The NGT will correct the operational deficiencies of the T-37 and incorporate new technologies that will significantly lower operating costs. In effect, it will pay for itself by using less fuel and needing less maintenance support. The primary phase of either generalized UPT or SUPT could use either the T-37 or the NGT.

The major impact on airspace requirements caused by the NGT will come from its programmed ability to fly higher and longer than the T-37. The primary training program will no longer be limited to altitudes below 25,000 feet. Thus, it will be possible to raise the floors and to increase

the ceilings of primary flying training airspace. This will require more controlled airspace above MOA altitudes. The greater maneuverability designed into the NGT will allow primary training airspace to have about the same lateral dimensions as at present. The longer range of the NGT should have a twofold impact on airspace used. First, navigation and local flying may be performed farther from the home station. This gives greater flexibility in designing MOAs but will complicate the coordination process because more agencies and people will be involved. At the same time, the greater range of the NGT will allow local flying more often on marginal weather days. Today, training flights are often impossible because no alternate landing site is within reach of the T-37. The NGT will be able to reach many more alternate bases even after completing an effective training sortie. This means that the ability to generate training sorties in poor weather will be greater than it is now. The result will be more efficient use of local airspace, which will actually reduce the need for airspace farther from the home station. The actual amount of flying training days saved is yet to be determined. Still, the amount of unproductive training time that is spent proceeding to and from training areas will be minimized by keeping training areas as close to the home base as possible.

The NGT design requirement is for a 1.5-hour sortie length. This is an increase of about 12 minutes over the average T-37 sortie length. Given a 3-minute launch interval, four more missions could be in flight at one time if the longer sortie length is adopted for the NGT. Additionally, the most effective sortie length is influenced by the student learning curves.[26] A greater number of sorties airborne at the same time would need more airspace. Yet, increased sortie length requires fewer sorties to

generate the same amount of flying hours. Ultimately, the reduction in weather losses will probably have the most impact on total airspace requirements.

Future Training Policy

Some general comments about future Air Force training policies and impacts of the specialized training program will follow. In line with Air Force needs to accomplish realistic training, the trend for ATC will be more flight and instrument training at night and at low levels. These concepts can be applied to the generalized system, and the development of the two tracks should take this into account. The flying skills used in the war-fighting environment should always be considered in developing the training course. Obviously, new student pilots have to start by learning the basics of flying, but later phases of training programs can and do emphasize these war-fighting skills. Realism could be enhanced by operating on low-level navigation routes with bomb-scoring capabilities, air refueling tracks, and drop zones. Added benefits would come from a closer involvement of both instructors and students in the operational environment.

With respect to total airspace needs, one of the largest factors is the number of students to be trained. The more students trained, the greater the airspace requirement. Actually, the airspace structure for a given base should be designed to support the base's maximum training capacity. Then if the base is not at its top capacity, the "extra" airspace can be used by any user, as is the case today. The same situation is true on weekends when no flying is being done from a base. For this reason, total airspace needs are dependent upon the degree to which bases require airspace for training purposes.

Basically, total training needs depend on force structure and retention. The system can be thought of as a big sink with water in it at some level. The water in the sink represents the number of pilots needed. This level depends on the force structure--that is, the number of aircraft, the number of pilots (the system could also represent any type of crewmember) per aircraft, and the crew ratios of the aircraft. The product of these factors, added to a management overhead structure, indicates the total number of pilots needed. Today's figure is about 24,000 pilots.[27] The water flowing in from the spigot represents the number of trained pilots entering the force; the water flowing out the drain represents pilots lost due to separations and so forth. To maintain the force level, the amount flowing in must equal the amount draining out. The rate flowing out can be determined by using the average length of time of service per pilot expected. So if the average length of service expected is 12 years, then 2,000 (24,000 divided by 12) pilots would have to enter to replace the 2,000 flowing out in a year. This is a sustainment factor. The pilot loss rates in 1979 were very high--about 8.7 years of service. The current expectation is actually for 13 years of service. This means about 1,850 new pilots per year will maintain the force size. Future pilot training rates will be very sensitive to loss rates and could vary significantly. In addition to the sustainment factor, pilots will have to be trained to fill current shortfalls in pilot inventories and to meet increases in force size.

Foreign training requirements and Reserve force training requirements need to be added to the required training capacity. Most foreign training is done in the EURO-NATO Joint Jet Pilot training program. For example,

the plan in Fiscal Year 1985 and beyond is to train about 50 foreign students in the UPT course and about 150 in the NATO course. Also, about 260 Reserve force pilots are to be trained in pilot training.

In the next few years prior to the SUPT implementation, some of the current pilot and navigator shortfall should be made up. To do this, the UPT system will have to operate at near capacity for the foreseeable future. This means total annual pilot production requirements most years will be 2,200 at the UPT bases and at least 260 per year from ENJJPT, of which 110 are USAF pilots. In addition, 103 helicopter pilots per year will be trained at Fort Rucker, Alabama, with the exception of 83 in Fiscal Year 1984. Forecasts for pilot training rates in the last 10 years of the century are derived from the extended planning annex (EPA). Based on a 6- to 8-percent increase in pilot force size,[28] the pilot force will be about 26,000 by the year 2000. This increases the sustainment requirement to about 150 pilots per year, plus about the same number each year to train the new pilots. Latest predictions are based on the EPA call for about 2,850 new pilots annually from 1992 and beyond. It should be noted that EPA force sizes have been optimistic in the past, and there has been a deficit of over 1,000 pilots in pilot inventories since Fiscal Year 1979.

Recent estimates of pilot production capacity for the SUPT are about 1,530 multiengine and about 880 FAR pilots (plus 110 from ENJJPT).[29] Including the 103 helicopter pilots typically produced, this totals 2,623. Because of relatively high crew ratios for multiengine aircraft, an estimated 70 percent of the pilot graduates will be needed from the TTB track. This means the production capacity for FAR pilots will be adequate, but there is not enough TTB production capacity in the system based on the

assumptions above. Many variables must be considered. Production capacities for the TTB track are rough estimates at this point. Further, a syllabus definition is required, and some experience with the system will be required to make more certain production capacity estimates. Pilot loss rates seem to be quite volatile. The current trends show improvement but are likely being influenced positively by the sluggish economy and its impact on airline expansion. The effects of future military personnel policies towards better retention, combined with the SUPT system refinements and other external influences, may eliminate the need for another TTB training base.

Current navigation training rates for active Air Force requirements are about 1,000 annually. Over 500 new Reserve force, Navy, Marine, Coast Guard, and foreign navigators are to be trained annually in the next few years. These high Air Force training rates are correcting shortfalls in navigator strengths. In the future, advances in technology should enhance aircraft navigation systems. The result will be a reduced need for navigators and slight reductions in training rates by about 10 percent.

Future force structure, retention, and training requirements tend to be a very complex and dynamic issue. Structure and particularly retention depend on many external influences that are uncontrollable. These topics would easily encompass a whole study. The conclusion here, other than the fact that more work needs to be done in this area, is that ways need to be available to expand pilot production capacity (particularly TTB pilots). Expanding to a new base may be the only alternative.

Factors Affecting Future Air Training Command Operations

The following discussion is included to stimulate thought and to help develop options for ATC in the future. The ATC headquarters staff experts have the best knowledge of command requirements and capabilities and should recommend the specific plans for the future. This study is intended to add insight to their planning process by providing a look at the external influences on the command training system and how much these influences will tend to affect competition for airspace requirements in the future. The primary focus, of course, is the requirement for airspace in the future, how best to fit it in, and what near-term actions would be useful to enhance the command's situation in the future.

Control of the NAS and the air traffic control system is now dominated by a civilian FAA. Although support of military requirements is generally very good, the main planning and future system design seem to favor civilian requirements. The support of military operations, other than point-to-point, will probably have to be worked in as an aberration to the system. Unless, of course, during the new system design, the DOD can exert the necessary influence to insure that the software is designed with the capability to support military needs. The conceptual system described by the FAA should be able to do this. The National Airspace Review Advisory Committee, the mechanism that would enable the DOD to insure that its future needs will be readily met, is already organized and working.

Civil airspace requirements can be expected to grow. General aviation needs will be increasing all over the country and climbing in the altitude structure. Larger trunk airline requirements will also have slight growth with intense pressure for direct routing. Even though growth rates

will be greater in the South and West, the northeastern quadrant of the country will remain the most competitive because of population density. Yet, any place where urban population centers are forming will tend to produce a highly competitive atmosphere for airspace and NAS system support.

The southern and more westerly locations are still the best areas for ATC to operate. Although the impact of weather will be we[illegible]ed somewhat by acquisition of the NGT and TTB aircraft, the impro[illegible]nt for the pilot training system is uncertain. Still, a wider range [illegible]lternative sites should be available if the command should need to [illegible] new flying locations.

Based on future training requirements, the command cannot afford to yield any of its current resources. After the NGT and TTB are operational, there will be excess T-38 aircraft and a possible reduction in some manpower needs. All other resources, including bases and airspace, will be needed. The final operational concept for the SUPT may ease local airspace requirements at TTB bases, but the use of airspace close to home is more efficient.

The challenge for the ATC program planners and airspace coordinators will be to find the optimum mix of close-to-home operations and operations at diverse locations in actual special-use airspace. How many times must students use actual air refueling routes, drop zones, and low-level routes to provide optimum training? The same holds true for the instrument training process. How many actual and different instrument approaches at fields away from home station will provide optimum training? Certainly, greater use of airspace close to home will allow a more efficient training program in the future.

As pointed out previously, the current base structure may not be able to support future needs. Because of high startup costs associated with new bases, however, every effort should be made to find new ATC operational locations at existing bases if they are required. Suppose, for example, that it becomes infeasible to teach all three instructor training courses at Randolph AFB. Could Kelly AFB be used to operate one of the instructor training courses? Instead of requiring a great deal of temporary duty for instructor pilots to TTB implementation bases to train cadre instructors, could Maxwell AFB be used as the training site? The instructor training course could be set up permanently at one of the TTB track bases, but it appears this may be the most limited track when compared to the training requirement. Can the command afford to use a TTB base's training capacity for instructor training?

In the future, intense competition for airspace and controller service will continue at Williams AFB, Randolph AFB, and Sheppard AFB. Any location near a large metropolitan area will have this problem. Added competition can be expected in Mississippi and south Texas from the Navy's training program, which is expected to expand somewhat in the future. However, ATC has at least equal priority for airspace and controller support. In fact, support of civil users helps only a limited few--from a single person in a light aircraft to an airliner with a few hundred passengers at most. Military flying activities benefit the total population.

There are opportunities on the horizon for significant improvements to the pilot training system. The SUPT graduate from either track will be a more qualified pilot at a lower total cost; realistic training can be enhanced; and the Air Force can expand its role within the NAS.

The FAA is currently planning vast enhancements to the NAS. The military should play a part in the system, especially in support of ATC's unique flying requirements. The command needs a safe environment for student training that can operate within the system. The environment must provide airspace and controller support that is conducive to training. Students must be able to develop pilot skills and judgment. Overly controlled and procedurized situations dictated by IFR clearances hamper the learning process. The FAA is not expected to give special flight-following oversight with limited intervention to ATC students, particularly in the future system. Yet, military approach controls can do this fairly easy. At the same time, the control of the airspace sectors will relieve the FAA's workload if it is given to military controllers.

When developing this future ATC airspace structure, a realistic environment should be a major consideration. Will an F-15 have to maintain a specific altitude and fly northeast of the target area while an airliner goes by? There certainly will be control in future military operations; but when in target areas (equivalent to ATC working areas), aircrews will be on their own to get their war-fighting job done. They will not depend upon a ground controller to tell them where to go. A military-controlled area around UPT bases will provide a much more realistic and effective training environment for ATC. At the same time, the support provided for civil flying requirements will enhance the NAS system. As the FAA upgrades its current support structure, the military should receive the new equipment so that the military control system will be a more integrated part of the NAS. At the very least, the replaced FAA equipment should be used by

military controllers if needed. One of the design criteria for the new equipment is compatibility with the replaced equipment.

Other technological and NAS improvements will support this approach to structuring the ATC environment. The T-CAS described in Chapter II will reduce the need for controllers to provide oversight for all aircraft. It should reduce the need for direct aircraft control. The FAA is planning on manpower savings from requiring T-CAS on all aircraft. The monitor and aircraft-flow metering needed by ATC is a manpower intensive operation--people have to do it. The Air Force can support its own requirement more effectively than the FAA can within the NAS.

The objective, therefore, becomes an environment around the ATC base totally controlled by the military. The ground approach, departure, and local area airspace will be controlled by Air Force controllers. Then, as increasing civil demands are felt, the command can insure that proper emphasis is given to its needs. These needs include specific services that provide the most effective, realistic training possible. In this environment, FAA organizational and personnel problems will have less impact on daily operations.

If adopted, this idea will require coordination and action by Air Force Communications Command (AFCC). In order to provide less restrictive flight-following service, more manpower authorizations are needed. However, this can be done more easily by using Air Force services than FAA services. Control of larger parcels of airspace will be required. Future plans by the FAA will lower the floor on the positive control area to as low as 6,000 feet, so, even given today's floor, the continuation of the current system would require a greater increment of the positive control area to be

under military control. Yet, this action will better integrate military air traffic control operations into the NAS and relieve some of the expanding workload expected by the FAA. The envisioned result would better integrate military personnel into the NAS and provide for ATC local control.

CHAPTER V

AIR TRAINING COMMAND OPERATING IN THE FUTURE NATIONAL AIRSPACE SYSTEM

The primary focus of this study has been to identify the impact of future ATC flying activities upon future command airspace requirements and to describe how these particular requirements will fit into the NAS. In order for the reader to better understand differing perspectives of the system as well as potential solutions for possible problem areas, the study reviewed the structure of both the FAA and the NAS. Then followed a short look at the future needs and plans of the system operators and other users so as to establish possible solutions. Finally, some implications of available options based upon previous analysis were examined. Overall conclusions and recommendations constitute the core of this final chapter.

The organizational development of the FAA continues to have considerable impact upon the NAS structure, a trend that may extend well into the future. US commercial airlines started the initial system; however, the government support for the development and subsequent exploitation of the US transportation system is a matter of public record. For instance, Congress underwrote the need to build up air commerce, to promote flying safety, and to support national defense. To support those multiple objectives, Congress created the organization which was to become the FAA. Moreover, a highly sophisticated NAS has evolved that supports commercial, point-to-point air operations very well. This same NAS infrastructure also supports military operations, but some military traffic is not readily compatible with the system. Military training requirements such as delays en route for high G maneuvering (simulated combat); high-speed, low-level

navigation and weapons delivery training; air refueling operations; and UPT "beehive" training activities are examples of unique military operations.

Initially, Congress intended for there to be a great deal of military participation within the FAA as evidenced by the fact that FAA personnel will become part of the military force during national emergencies. But in reality, there exists little military presence within the FAA top management, nor is there any agreement between the military and the FAA concerning creation of a federal aviation service during prior development of the system.

As the size of commercial and general aviation operations have overtaken and far exceeded the number of military operations, the NAS has provided maximum support to those users with the highest volume. Nevertheless, there does remain some fear that a large government organization like the FAA will forget that it exists solely to provide a unique service to the American people. In fact, the private sector keeps constant pressure on the FAA to provide the types of service it needs; the military does not seem able to exert the same pressure. However, there do exist lines of communication and procedures for the military to work within the FAA infrastructure. The process, while slow and cumbersome, eventually is responsible to user requirements.

To enhance future responsiveness, the FAA is planning many improvements. The agency will use modern technology to automate its support services which, in turn, will reduce the manpower intensiveness of its operations. Administrator Helms claims the current system is already approaching its safe service limits at existing terminal areas. This might create future problems in the system, such as a reduction in service in comparison with projected user demands. So in order for users to operate

in the future NAS, they will need to cooperate closely with the FAA. An example will be a requirement to have specific airborne equipment in order to operate at higher altitudes. T-CAS is one such future requirement, just as communications radios and radar transponders were in past years. Other system users are forecasting changes as well.

The future always has uncertainties, but there are some definite economic and demographic trends that may well influence future airspace requirements for civil as well as military needs. For example, the future growth of commercial airline traffic hinges upon certain economic factors and population growth. Previous research indicates how these economic factors tend to influence the demand for air travel. Increases in personal income, the occupational mix of area populations, and the relative cost of air travel compared to other means of conveyance are some of the relevant influential variables in assessing future growth. It should also be noted that the interrelationships among these variables remain relative. For instance, a rise in air fares is not as important as the change in the relative cost of air fares compared to other means of transportation such as automobiles. Also, assuming that the country's economy overcomes its present difficulties and begins to experience real growth again, any increase in spendable income or reduced unemployment will spur heightened demand for air travel.

While the population of the United States will continue to increase, specific areas of the country (the Sun Belt and Pacific Northwest) will continue to grow more rapidly. These two areas may experience the greatest increase in demand for airspace for private flying and commercial air travel. Because the greatest population densities remain on the coasts and in the Northeastern quadrant of the country, it follows that a larger population

will produce a larger demand for air travel. Even as metropolitan airport facilities become saturated, local area air operations continue to grow with the addition of new runways and other support facilities to meet an increasing demand by users. Examples are the recently added runway at Atlanta and the expanded use of the Ontario Airport near Los Angeles.

Airline deregulation and increased fuel prices will also probably have additional significant impacts on civil demand for airspace. Larger airlines will opt for larger capacity (wide body), newer, more fuel-efficient aircraft to keep fares down and to cope with increased demand. Yet, trunk airlines cannot keep up with demand. As larger carriers discontinue less profitable short routes (that is, less profitable for larger aircraft), commuter airlines and business flying will fill the void and raise the civil demand for airspace. Should the economy expand, more aircraft from these two sectors will compete increasingly with the large carriers for finite airspace. ATC personnel are particularly aware that Phoenix, Arizona, will become a commuter hub and that competition for airspace in that area is already a problem. But each base location is unique. Those closer to urban centers will be hard pressed to resolve successfully the airspace allocation problem.

Also, as competition for FAA support increases with increased commuter and business traffic, there could well be a trend for many more non-FAA controlled aircraft flying in the environment--i.e., visual flight without radar control. This will not only increase the potential for midair accidents but also will reduce the safety factor for all lower-altitude flyers. But even as ATC modernizes or replaces the T-37 and increases operating altitudes to avoid the present midair risk, there will be more civil aircraft used for business purposes that have the capability of

operating at higher altitudes. In the future, both commercial and general aviation will need increasing airspace. Civilian aviation will continue to have a strong influence over the legislative process to get the services it desires. Proponents of civil aviation have to respond to economic realities, which they are able to articulate effectively to Congress and to the general public.

In contrast, future mil` ary airspace needs will react to both quantitative and qualitative factors. Force sizes are programmed to grow only slightly as are per-pilot-flying-time allocations. This means that while the amount of military operations will grow only slightly, they will decline in relative terms proportionate to what is projected for civil operations. However, the way the military will train in the future, including the quality of training, does indicate certain new trends. This evolving military requirement means that the actual pieces of airspace needed may change somewhat. Certainly, the ability to simulate combat conditions has proven essential for the maintenance and readiness of US combat forces. Experience from recent conflicts demonstrates that in modern aerial combat in complex defensive environments, the ability to fly very low at high speeds is essential. Also, there remains the requirement to operate around the clock in all-weather conditions. The US Air Force believes that the Soviets cannot be given free rein to operate numerically superior ground and air forces at night and in poor weather. These superimposed realities mandate the need for joint service training that provides highly realistic training situations. Such an approach will affect all future Air Force aerial training concepts. There will be no appreciable change in the amount of airspace and air traffic control support that the military establishment needs to support future training requirements.

In general, other future DOD airspace requirements will not adversely affect ATC to any great extent. Navy, Marine, and Coast Guard operations are mostly at coastal locations. The Army primarily trains helicopter pilots at altitudes below most Air Force flying operations. If anything, the required additional joint use of low-level routes will help to make more efficient use of airspace and to stimulate cooperation in any joint training arena.

But some specific changes within the future Air Force flying environment will increase MAC's requirements for air refueling and low-level navigation training. SAC will have to base new systems (e.g., the B-1) and move old ones so as to avoid future vulnerability from external threats to national security. This has resulted in plans for a strategic training range complex in the north central part of the country. This range complex will reduce SAC's airspace requirements in the more crowded Northeastern and Southeastern quadrants of the country, thus further enhancing future Air Force training effectiveness. Further, this range complex will provide more realistic training with multiple practice bombing and electronic countermeasure sites, fighter intercepts, and areas for live weapons practice. This geographical consolidation will move USAF training sites closer to the base locations they will be supporting, thus resulting in the more efficient use of airspace and partially freeing up a portion of the more congested airspace for civil use.

In the fighter arena, USAF tactical forces currently have the outstanding Red Flag program in Nevada that provides integrated realistic training, but more is required. In order to train realistically, fighter aircrews will also need to do more navigation training at night and at low levels near their base locations across the country, which will increase

competition for this type of airspace. To provide heightened realism, all DOD flight operations will be working even more closely in joint operations than at present. ATC should work to provide pilots that are better trained to support these changing requirements.

Given such requirements then, how should ATC's airspace needs be structured for the future? First, even though the FAA is ultimately responsive, the recent PATCO strike has helped to demonstrate that there still remains a better way to operate. Hence, ATC should strive for local control of airspace by military radar controllers who can provide effective service to ATC bases. In addition to this local role, Air Force controllers are part of the NAS since they are an integral part of the FAA control system that supports civil air traffic. This military-civilian integration expands the system's overall capacity to support expanded military and civilian use.

While the communications process is inherently simpler between Air Force personnel of an ATC base and personnel of AFCC, the support requirements of the pilot training bases need to be more clearly defined. IFR aircraft separation criteria normally are not required or desired by ATC bases. Yet, when told IFR separation is necessary, traffic control supporting agencies apply the restrictive criteria defined by FAA regulations for the IFR environment. In reality, however, the concept that is needed in most circumstances for effective UPT is radar flight following. This situation is true regardless of who is supporting the operation. Because radar flight following is a manpower-intensive operation, however, the Air Force enjoys an advantage over the FAA in that an Air Force-managed system would be more flexible, adaptable, and responsive to wartime requirements.

Also, this concept increases the training capacity of currently available airspace by reducing the requirement for airspace buffers.

But this training capacity at existing ATC bases will be severely taxed in the future. A slight growth in pilot and navigator force sizes is expected, but even this modest increase will require more than the 95 percent of training plant capacity in use today. More specifically, the airspace congestion near Phoenix, at Williams AFB, will further reduce training capacity there. In fact, should US economic recovery occur, this change in economic conditions will create intense competition for this country's pilot resources. Today, the pilot and navigator forces have reached the end of a 15-year drawdown. There is little reserve to draw from in a crisis. If the current force structure is to be maintained, pilot absorption capability within all commands will require improvement. It thus appears that future training requirements of the rated force will be appreciably greater.

It follows that ATC must avoid giving up <u>any</u> of its current resources, including airspace, since there will be continued competition for airspace from a civilian population. This is also true of land areas near training bases. The small number of military pilots trained in 1979 and 1980 gave false hope to civilian aviation advocates and FAA officials that ATC could easily give up some airspace and land resources when, in fact, the opposite is true. The time has come to consider UPT site expansion in case adequate support is not provided at current training locations. ATC will be operating new aircraft--the T-37 replacement and the multiengine trainer. These aircraft will have better weather penetration capabilities and range. Therefore, in addition to southern sites such as Webb AFB, the search could be expanded further north into the central region of the country.

More specific future airspace structure requirements are necessary to insure that the Air Force produces enough well-qualified pilots for the gaining commands. The change to specialized pilot training tracks supports this point. The qualitative factors are mentioned earlier. Training should take place in a realistic environment. The fighter track will increase airspace needs because of increased sorties in the program. Increased low-level navigation, aerial refueling, and night operations are possible and desirable.

The new multiengine trainer requires restructuring of flying areas around multiengine bases to provide the most effective mix of local flying and special-use airspace. To this end, training flights should use existing routes and refueling areas, where feasible, so as to help optimize the specialized training program. To provide realistic training and more flexibility, plans should be made for visual clearance flying. All of these actions will help increase the current base training capacity and will provide more realistic training.

In any event, ATC should seek to expand local control of airspace near pilot training bases. Cooperation with home-based military controllers would be faster, and specialized flight-following procedures could be implemented more easily. In this way, personalized control would be less expensive, yet more effective. Also, the military would be helping to control a larger share of the NAS, thereby allowing more FAA personnel to give increased service to other system users. This action would also reduce total system costs since, among other things, military manpower is less expensive than FAA manpower.

But the American public wants access to all airspace, and this access could be granted and supervised by military controllers. However, the setting of priorities for airspace use near all ATC bases would now be done by military rather than civilian controllers. Less disruption of pilot training missions should be the result. If just 5 minutes could be saved on every sortie in the present training system by avoiding diversion for civil aircraft, there would be an estimated savings of about $10 million worth of fuel each year. There would also be significant savings in instructor pilot and support personnel manpower expenses.

Another major recommendation is that military training bases should be treated like other high-density terminal airport areas with congested traffic patterns. To this end, general aviation and commercial aircraft should not as a rule be allowed access through these areas. If more federal regulations are needed to establish special-use, limited access airspace for pilot training operations, the real value in terms of increased safety for all users and dollar savings in military training will appreciably offset the price and the inconvenience of such regulations.

An alternative to limited access to close-in airspace would be increased control over areas farther away. But the cost of more flying time to travel to and from these areas would require increased budgeting by the command to cover these additional program costs. Added flying time necessitates more fuel, instructor and support manpower, and added systems equipment costs for pilot training programs. The Air Force should clearly point out the cost of FAA decisions that make Air Force training programs less efficient and result in lower operational force readiness because of dollars diverted to training programs. The democratic principles of this

society support preserving national airspace for public use. Yet, there is also a responsibility to provide national defense efficiently and economically.

Another alternative would be for ATC to open new bases in areas where there is less civil competition for airspace. This could mean simply opening one more base, or opening one and closing another. This is an expensive option: the estimated annual recurring and fixed cost for a sixth base is about $70 million. Just moving an operation to a new base would involve something over $300 million in facilities and equipment, not counting base closure, movement, or land acquisition costs. Lastly, the politics of opening and closing bases becomes an issue. Because of the problems involved in opening or closing bases, this alternative is not an optimum answer for resolving the airspace problem.

Balancing the public interest between free access to airspace and efficiently supporting national defense is difficult, and the economic and political stakes are high. ATC's priority should be to first operate efficiently with local control and use of the closest airspace to current training bases. There is adequate airspace near these bases for future military users if growing civil demands are handled properly. This represents the most efficient airspace structure for ATC in the future flying environment unless unforeseen demands are placed on the ATC training system.

APPENDIX

This Appendix lists the bases and flying locations shown in the figures throughout this monograph. Abbreviations for branches and units are as follows:

A	- US Army
AF	- US Air Force
AFRES	- US Air Force Reserve
ANG	- US Air National Guard
AR	- US Army Reserve
CG	- US Coast Guard
MC	- US Marine Corps
N	- US Navy
NARF	- US Naval Air Reserve Facility
NASA	- National Aeronautics & Space Administration
NG	- US Army National Guard

ATC	- Air Training Command
MAC	- Military Airlift Command
SAC	- Strategic Air Command
TAC	- Tactical Air Command
AFLC	- Air Force Logistics Command
AFSC	- Air Force Systems Command

NAVY/MARINE INSTALLATIONS WITH INSTRUMENT OR RADAR APPROACH

Branch	Other Units	Installation	State
N		Alameda NAS (Nimitz Field)	CA
MC		Beaufort MCAS (Merritt Field)	SC
MC		Bogue MCALF (Newport) (Cherry Point)	NC
N		Brunswick NAS	ME
N		Calverton NW Indust Res Plant (Peconic Field) Long Island	NY
MC		Camp Pendleton MCAF (Oceanside) San Diego	CA
N		Cecil Field NAS (Jacksonville)	FL
N		Chase Field NAS (Beeville)	TX
MC		Cherry Point MCAS (Cunningham Field) Cherry Point	NC
N		China Lake NWC (Armitage Field)(Ridgecrest)(Edwards) AUX	CA
N	CG,A	Corpus Christi NAS	TX
N		Crows Landing NALF Stockton	CA
N	ANG,NG,AR	Dallas NAS (Hensley Field)	TX
N		El Centro NAF	CA
MC		El Toro MCAS (Santa Ana)	CA
N		Fallon NAS (Van Voorhis Field)	NV
N	CG,A,AR	Glenview NAS Chicago	IL
N		Imperial Beach OLF (Ream Field) San Diego	CA
N		Jacksonville NAS (Towers Field)	FL
N		Key West NAS (Boca Chica Field)	FL
N		Kingsville NAS	TX
N	A	Lakehurst NAEC McGuire	NJ
N		Lemoore NAS (Reeves Field)	CA

Navy/Marine Installations (Continued)

Branch	Other Units	Installation	State
N		Memphis NAS (Millington)	TN
N		Meridian NAS (McCain Field)	MS
N		Miramar NAS (Mitscher Field) San Diego	CA
N	ANG	Moffett Field NAS (Mountain View)	CA
N	CG,AFRES,ANG	New Orleans NAS (Alvin Callander Field) AFRES	LA
MC		New River MCAS (McCutcheon) Jacksonville, Cherry Point	NC
N		Norfolk NAS (Chambers Field)	VA
N		North Island NAS (Halsey Field) San Diego	CA
N		Oceana NAS (Soucek Field) Norfolk	VA
N		Patuxent River NAS (Trapnell Field)	MD
N		Pensacola NAS (Forrest Sherman Field)	FL
N		Point Mugu NAS	CA
MC		Quantico MCAF (Turner Field)	VA
N		San Clemente Island NALF (Frederick Sherman Field)	CA
N		San Nicolas Island OLF	CA
N		South Weymouth NAS (Shea Field) Boston	MA
MC		Tusten MCAS(H) El Toro	CA
MC		Twentynine Palms EAF (Expeditionary Air Field)	CA
N		Warminster NADC Philadelphia	PA
N		Whidley Island NAS (Alt Field)	WA
N		Whiting Field NAS-North (Milton) Pensacola	FL
N		Whiting Field NAS-South (Milton) Pensacola	FL
N	AFRES,AR,ANG	Willow Grove NAS Philadelphia AFRES	PA
MC		Yuma MCAS/Yuma International	AZ

Army Fields

Branch	Other Units	Installation	State
A		Amedee AAF (Seirae Army Depot) (Herlong)	CA
A		Biggs AAF (Fort Bliss)	TX
A		Blackstone AAF (Allen C. Perkinson Muni) (Fort Pickett)	VA
A		Butts AAF (Ft Carson) (Colorado Springs)	CO
A		Cairns AAF (Ft Rucker)	AL
A		Campbell AAF (Ft Campbell) (Hopkinsville)	KY
A	NG	Davison AAF (Ft Belvoir)	VA
A		Felker AAF (Ft Eustis)	VA
A		Forney AAF (Fort Leonard Wood)	MO
A		Fritzsche AAF (Fort Ord)	CA
A		Godman AAF (Ft Knox)	KY
A	NG	Gray AAF (Ft Lewis)	WA
A		Hamilton Field (San Rafael)	CA
A		Hanchey AHP (Ft Rucker)	AL
A		Henry Post AAF (Ft Sill)	OK
A		Hood AAF (Ft Hood)	TX
A	CG/NG	Hunter AAF (Savannah) (Ft Stewart Wright)	GA
A		Laguna AAF (Yuma Proving Ground)	AZ
A		Lawson AAF (Ft Benning)	GA
A		Libby AAF/Sierra Vista Municipal (Ft Huachuca)	AZ
A		Lowe AHP (Ft Rucker)	AL
A		Mackall AAF (Camp Mackall) (Ft Bragg)	NC
A		Marshall AAF (Ft Riley)	KS

Army Fields

Branch	Other Units	Installation	State
A		Michael AAF (Dugway Proving Ground)	UT
A	AR	Moore AAF (Fort Devens)	MA
A	NG	Muir AAF (Ft Indiantown Gap) (Annville)	PA
A		Phillips AAF (Aberdeen Proving Grounds)	MO
A		Polk AAF (Ft Polk)	LA
A		Redstone AAF (Redstone Arsenal) (Huntsville)	AL
A		Robert Gray AAF (Ft Hood) (Austin)	TX
A		Sabre AHP (Ft Campbell)	KY
A		Seneca AAF (Ramulies) (Rochester)	NY
A		Sherman AAF (Ft Leavenworth)	KS
A		Simmons AAF (Ft Bragg) (Fayetteville)	NC
A		Tipton AAF (Ft Meade) (Baltimore)	MD
A		Wheeler-Sack AAF (Ft Drum) (Watertown), (Ft Revers)	NY
A		Wright AAF (Ft Stewart) (Linesville)	GA

Air Force Fields

MAJCOM	Other Units	Installation	State
MAC		Altus Air Force Base	OK
MAC	ANG,AFRES,N	Andrews Air Force Base	MD
AFSC		Arnold Air Force Station	TN
SAC		Barksdale Air Force Base	LA
SAC		Beale Air Force Base	CA
TAC	AFRES	Bergstrom Air Force Base	TX
SAC		Blytheville Air Force Base	AR
TAC		Cannon Air Force Base	NM
SAC	AFRES	Carswell Air Force Base	TX
SAC		Castle Air Force Base	CA
MAC		Charleston Air Force Base	SC
ATC		Columbus Air Force Base	MS
TAC		Davis-Monthan Air Force Base	AZ
MAC		Dover Air Force Base	DE
SAC		Dyess Air Force Base	TX
AFSC	A	Edwards Air Force Base	CA
AFSC		Eglin Air Force Base	FL
		Eglin Air Force + AUX Nr 3 Duke	
SAC		Ellsworth Air Force Base	SC
TAC		England Air Force Base	LA
SAC		Fairchild Air Force Base	WA
TAC		George Air Force Base	CA
SAC		Grand Forks Air Force Base	ND
SAC		Griffis Air Force Base	NY

Air Force Fields

MAJCOM	Other Units	Installation	State
SAC		Grissom Air Force Base	IN
AFLC		Hill Air Force Base	UT
TAC	A	Holloman Air Force Base	NM
TAC		Homestead Air Force Base	FL
TAC		Hurlburt Field	FL
ATC		Keesler Air Force Base	MS
AFLC	ANG,AFRES	Kelly Air Force Base	TX
SAC		K.I. Sawyer Air Force Base	MI
TAC	NASA,A	Langley Air Force Base	VA
ATC		Laughlin Air Force Base	TX
MAC		Little Rock Air Force Base	AR
SAC		Loring Air Force Base	ME
TAC		Luke Air Force Base	AZ
TAC	A	MacDill Air Force Base	FL
SAC		Malmstrom Air Force Base	MT
SAC		March Air Force Base	CA
ATC	NG,AFRES	Mather Air Force Base	CA
ATC		Maxwell Air Force Base	AL
MAC		McChord Air Force Base	WA
AFLC		McClellan Air Force Base	CA
SAC	ANG	McConnell Air Force Base	KS
MAC	A,ANG	McGuire Air Force Base	NJ
SAC		Minot Air Force Base	ND
TAC		Moody Air Force Base	GA

Air Force Fields

MAJCOM	Other Units	Installation	State
TAC		Mountain Home Air Force Base	ID
TAC		Myrtle Beach Air Force Base	SC
TAC		Nellis Air Force Base	NV
MAC		Norton Air Force Base	CA
SAC		Offutt Air Force Base	NE
		Palmdale Production Flt/Test AF Plant Nr42	CA
AFSC		Patrick Air Force Base	FL
SAC		Pease Air Force Base	NH
SAC		Plattsburg Air Force Base	NY
MAC		Pope Air Force Base	NC
ATC	A	Randolph Air Force Base	TX
ATC		Reese Air Force Base	TX
AFLC		Robins Air Force Base	GA
MAC	AR	Scott Air Force Base	IL
TAC		Seymour Johnson	NC
TAC		Shaw Air Force Base	SC
ATC		Sheppard AFB, Wichita Falls Municipal	TX
AFLC		Tinker Air Force Base	OK
MAC		Travis Air Force Base	CA
TAC		Tyndall Air Force Base	FL
ATC		Vance Air Force Base	OK
SAC		Vandenberg Air Force Base	CA
SAC	NG	Whiteman Air Force Base	MO

Air Force Fields

MAJCOM	Other Units	Installation	State
ATC		Williams Air Force Base	AZ
AFLC		Wright-Patterson	OH
SAC		Wurtsmith Air Force Base	MI

Private Fields With Active Military Units

Branch	Installation	State
AF	Albuquerque International (Kirtland AFB)	NM
A	Anniston-Calhoun County (Anniston Army Depot)	AL
CG	Arcata (Eureka)	CA
CG	Bates Field (Mobile)	AL
A	Bi-State Parks (East St. Louis)	IL
A	Bash Field (Augusta) Ft Gordon	GA
A	Capital City (Lewisburg)	PA
A	Chambersburg Municipal (Lewisburg)	PA
CG	Cherry Capital (Traverse City)	MI
AF	Cheyenne	WY
AF	Chico Municipal	CA
AF	City of Colorado Springs Municipal (Peterson AFB)	CO
A	Columbia Metropolitan	SC
A	Enterprise Municipal	AL
A	Fresno Air Terminal (Oakland)	CA
A	Fulton County Airport-Brown Field (Atlanta)	GA
A	Indianapolis International	IN
N	Kitsap County (NAS Whidby)	WA
AF/N	Lambert-St Louis International (McDonnell)	MO
AF/CG	Los Angeles International	CA
AF	Marion County (Hamilton)	AL
A	Monmouth County (Belmar)	NJ
A	Morristown Municipal	NJ
AF	New Hanover County	NC

Private Fields With Active Military Units

Branch	Installation	State
CG	North Bend Municipal	OR
A	Oakland-Pontiac	MI
CG	Opa-Locka (Miami)	FL
AF	Orlando International	FL
N	Port Columbus International (Rockwell)	OH
CG	Port of Astoria (Portland)	OR
A	Quad-City (Moline)	IL
CG	St Petersburg-Clearwater International	FL
A	San Antonio International	TX
CG	San Diego International-Lindberg Field	CA
CG	San Francisco	CA
A	Stewart (Newburgh)	NY
A	Troy Municipal (Cairns, Ft Rucker)	AL

Base Breakout Of Reserve And Special Components

Base		Tenants	State
CG Bases	Elizabeth City, CGAS/Municipal		NC
	Port Angeles, CGAS Heliport		WA
AFRES	Dobbins AFB	N/ANG/AR	GA
	Richards-Gebaur AFB		MO
	Westover AFB	NG	MA
ANG	Buckley ANGB	A/AF/N/MC/NG/NARF	CO
	Ellington AFB	CG/NASA/NG	TX
	McEntire ANG Base	NG	SC
	Otis ANGB	CG/NG	MA
	Rickenbacker ANGB	AFRES	OH
	Selfridge ANGB	CG/AR/AFRES/NARF	MI
AR	McCoy AAF (Fort McCoy)		WI
NG	Grayling AAF (Camp Grayling)	NG	MI
	Los Alamitos AAF (Armed Forces Reserve Center)	N/AR	CA
	Ray S. Miller, AAF (Camp Ripley)		MN
NASA	NASA Wallops Flight Center		VA

Private Fields With Tenant Units

Unit	Installation	State
NG	Abrams Municipal	Mi
AR	Acadiana Regional	LA
AR	Adams Field	AR
NG	Akron-Canton	OH
NG	Albany County	NY
AF/ANG	Albuquerque International	NM
ANG	Allen C. Thompson	MS
A	Anniston-Calhoun County	AL
CG	Arcata	CA
ANG	Atlantic City	NJ
ANG/NG	Bangor International	ME
ANG	Barnes Municipal	MA
CG	Bates Field	AL
ANG/NG	Birmingham Municipal	AL
NG	Bismarck Municipal	ND
A	Bi-State Parks	IL
ANG/NG	Boise Air Terminal	ID
NG	Boone Municipal	IA
AR	Bowman Field	KY
ANG/NG	Bradley International	CT
ANG/NG	Burlington International	VT
A	Bush Field	GA
ANG	Capitol	IL
NG	Capitol City	KY

Private Fields With Tenant Units (Continued)

Unit	Installation	State
A	Capitol	PA
NG	C. D. Temons Municipal	MS
A	Chambersburg Municipal	PA
CG	Cherry Capitol	MI
AF/ANG/NG	Cheyenne	WY
NG	Chicago Michway	IL
AFRES/ANG	Chicago-O'Hare International	IL
AF	Chico Municipal	CA
AF	City of Colorado Springs Municipal	CO
AR	Cleveland-Hopkins International	OH
AR	Coeur d'Alene Air Terminal	ID
A/AR	Columbia Metropolitan	SC
NG	Concord Municipal	NH
NG	Craig Municipal	FL
ANG/NG	Dane County Regional/Truax Field	WI
ANG/NG	Dannelly Field	AL
NG	Davenport Municipal	IA
NG	Decatur	IL
ANG/AR	Des Moines Municipal	IA
ANG	Douglas Municipal	NC
ANG	Duluth International	MN
ANG	Eastern WV Regional/Shepherd Field	WV
A	Enterprise Municipal	AL
ANG/NG	Forbes Field	KS

Private Fields With Tenant Units (Continued)

Unit	Installation	State
ANG	Fort Smith Municipal	AR
ANG	Fort Wayne Municipal	IN
A/ANG/NG	Fresno Air Terminal	CA
A	Fulton County Airport-Brown Field	GA
AFRES/ANG/AR	General Mitchell Field	WI
ANG	Glenn L. Martin State	MD
ANG	Greater Peoria	IL
AFRES/ANG	Greater Pittsburgh International	PA
ANG/NG	Greater Wilmington	DE
ANG/NARF	Great Falls International	MT
NG	Grider Field	AR
NG	Groton-New London	CT
ANG/NG	Gulfport-Biloxi Regional	MS
ANG	Harrisburg International-Olmsted Field	PA
NG	Hawkins Field	MS
ANG	Hayward Air Terminal	CA
ANG	Hector Field	ND
NG	Helena	MT
ANG	Hulman Regional	IN
AR	Indianapolis Brookside Airpark	IN
A	Indianapolis International	IN
ANG	Jacksonville International	FL
NG	Jefferson City Memorial	MO
ANG	Joe Foss Field	SD

Private Fields With Tenant Units (Continued)

Unit	Installation	State
AR	Johnson County Industrial	KS
ANG	Kanawha	WV
ANG/NG	Key Field	MS
ANG	Kingsley Field	OR
N	Kitsap	WA
NG	Lakefront	LA
AF/N/ANG	Lambert-St Louis International	MO
ANG/NG	Lincoln Municipal	NE
NG	Linden	NJ
NG	Long Island MacArthur	NY
AF/CG	Los Angeles International	CA
ANG	Mansfield Tahm Municipal	OH
AF	Marion County	AL
AR	Max Westheimer	OK
ANG/NG	McGhee Tyson	TN
NG	McNary Field	OR
ANG	Memphis International	TN
NG	Mercer County	NJ
AFRES/ANG	Minneapolis-St Paul International	MN
A	Morristown Municipal	NJ
ANG	Nashville Metropolitan	TN
AF	New Hanover County	NG
AFRES/ANG/NG	Niagara Falls International	NY
CG	North Bend Municipal	OR

Private Fields With Tenant Units (Continued)

Unit	Installation	State
A	Oakland-Pontiac	MI
NG	Ohio State University	OH
ANG	Ontario International	CA
CG	Opa-Locka	FL
AF/AR	Orlando International	FL
AR	Pearson Airpark	WA
AR	Petersburg Municipal	VA
ANG	Phelps-Collins	MI
ANG	Phoenix-Sky Harbor International	AZ
ANG	Portage Municipal	WI
N/AR	Port Columbus International	OH
AFRES/ANG	Portland International	OR
CG	Port of Astoria	OR
A	Quad-City	IL
NG/ANG	Quonset State	RI
NG	Raleigh-Durham	NC
NG	Rapid City Regional	SD
ANG	Reno Cannon International	NV
NG	Reno/Stead	NV
ANG/NG	Richard Evelyn Byrd International	VA
NG	Robert Mueller Municipal	TX
ANG	Rosecrans Memorial	MO
NG	Rowan County	NC
AR	St Clair County	AL

Private Fields With Tenant Units (Continued)

Unit	Installation	State
AR/NG	St Paul Downtown Holman Field	MN
CG	St Petersburg-Clearwater International	FL
ANG/AR	Salt Lake City International	UT
NG	Salt Lake City Municipal 2	UT
CG	San Diego International-Lindbergh Field	CA
CG	San Francisco International	CA
NG	Santa Fe County Municipal	NM
ANG	Savannah Municipal	GA
ANG	Schenectady County	NY
NG	Shelbyville Municipal	IN
ANG	Sioux City Municipal	IA
NG	Smyrna	TX
AR	Snohomish County/Plaine Field	WA
NG	Spokane International	WA
ANG	Springfield Municipal	OH
NG	Springfield Regional	MO
ANG	Standiford Field	KY
A/AR	Stewart	NY
NG	Stockton Metropolitan	CA
ANG	Suffolk County	NY
ANG,AR	Syracuse Hancock International	NY
ANG	Toledo Express	OH
A	Troy Municipal	AL
ANG	Tucson International	AZ

Private Fields With Tenant Units (Continued)

Unit	Installation	State
ANG,NG	Tulsa International	OK
ANG	Van Nuys	CA
AR	Vicksburg Municipal	MS
NG	Washington County	PA
AR	Washington County Regional	MD
NG	Waterloo Municipal	IA
NG	West Bend Municipal	WI
ANG	Westchester County	NY
ANG	Will Rogers World	OK
NG	Winder	GA
ANG	W. K. Kellogg Regional	MI
NG	Wood County-Gill Roff Wilson Field	WV
AFRES	Youngstown Municipal	OH

Primary and Tenant Airfields Used By Air Force Command

Air Training Command

Operating Bases	State
Chanute Air Force Base	IL
Columbus Air Force Base	MS
Goodfellow Air Force Base	TX
Gunter Air Force Station	AL
Keesler Air Force Base	MS
Lackland Air Force Base	TX
Laughlin Air Force Base	TX
Lowry Air Force Base	CO
Mather Air Force Base	CA
Maxwell Air Force Base	AL
Randolph Air Force Base	TX
Reese Air Force Base	TX
Sheppard Air Force Base	TX
Vance Air Force Base	OK
Williams Air Force Base	AZ

Tenant Bases	State
Fairchild Air Force Base	WA
Homestead Air Force Base	FL
Peterson Air Force Base	CO
USAF Academy	CO
Wright-Patterson Air Force Base	OH

Primary and Tenant Airfields Used By Air Force Command

Military Airlift Command

Operating Bases	State
Altus Air Force Base	OK
Andrews Air Force Base	MD
Bolling Air Force Base	MD
Charleston Air Force Base	SC
Dover Air Force Base	DE
Kirtland Air Force Base	NM
Little Rock Air Force Base	AR
McChord Air Force Base	WA
McGuire Air Force Base	NJ
Norton Air Force Base	CA
Pope Air Force Base	NC
Scott Air Force Base	IL
Travis Air Force Base	CA

Tenant Bases	State
Davis-Monthan Air Force Base	AZ
Dyess Air Force Base	TX
Edwards Air Force Base	CA
Eglin Air Force Base	FL
Ellsworth Air Force Base	SD
Fairchild Air Force Base	WA
Francis E. Warren Air Force Base	WY
Grand Forks Air Force Base	ND

Primary and Tenant Airfields Used By Air Force Command

Military Airlift Command (Continued)

Tenant Bases	State
Hill Air Force Base	WA
Holloman Air Force Base	NM
Homestead Air Force Base	FL
Keesler Air Force Base	MS
Langley Air Force Base	VA
Luke Air Force Base	AZ
Malmstrom Air Force Base	MT
McClellan Air Force Base	CA
McConnell Air Force Base	KS
Minot Air Force Base	ND
Mountain Home Air Force Base	ID
Myrtle Beach Air Force Base	SC
Patrick Air Force Case	FL
Peterson Air Force Base	CO
Plattsburg Air Force Base	NY
Richards-Gebaur Air Force Base	MO
Tyndall Air Force Base	FL
Vandenberg Air Force Base	CA
Whiteman Air Force Base	MO
Wright-Patterson Air Force Base	OH

Primary and Tenant Airfields Used By Air Force Command

Strategic Air Command

Operating Bases	State
Barksdale Air Force Base	LA
Beal Air Force Base	CA
Blytheville Air Force Base	AR
Carswell Air Force Base	TX
Castle Air Force Base	CA
Dyess Air Force Base	TX
Ellsworth Air Force Base	SD
Fairchild Air Force Base	WA
Francis E. Warren Air Force Base	WY
Grand Forks Air Force Base	ND
Griffiss Air Force Base	NY
Grissom Air Force Base	IN
K. I. Sawyer Air Force Base	MI
Loring Air Force Base	ME
Malmstrom Air Force Base	MT
March Air Force Base	CA
McConnell Air Force Base	KS
Minot Air Force Base	ND
Offutt Air Force Base	NE
Pease Air Force Base	NH
Peterson Air Force Base	CO
Plattsburg Air Force Base	NY

Primary and Tenant Airfields Used By Air Force Command

Strategic Air Command (Continued)

Operating Bases	State
Vandenberg Air Force Base	CA
Whiteman Air Force Base	MO
Wurtsmith Air Force Base	MI

Tenant Bases	State
Altus Air Force Base	OK
Little Rock Air Force Base	AR
Mather Air Force Base	CA
Robins Air Force Base	GA
Seymour Johnson Air Force Base	NC
Travis Air Force Base	CA

Primary and Tenant Airfields Used By Air Force Command

Tactical Air Command

Operating Bases	State
Bergstrom Air Force Base	TX
Cannon Air Force Base	NM
Davis-Monthan Air Force Base	AZ
Duluth International Airport	MN
England Air Force Base	LA
George Air Force Base	CA
Hancock Field	NY
Holloman Air Force Base	NM
Homestead Air Force Base	FL
Hurlburt Field	FL
Indian Springs Auxiliary	NV
Langley Air Force Base	VA
Luke Air Force Base	AZ
MacDill Air Force Base	FL
Moody Air Force Base	GA
Mountain Home Air Force Base	ID
Myrtle Beach Air Force Base	SC
Nellis Air Force Base	NV
Seymour Johnson Air Force Base	NC
Shaw Air Force Base	SC
Tyndall Air Force Base	FL

Primary and Tenant Airfields Used By Air Force Command

Tactical Air Command (Continued)

Tenant Bases	State
Castle Air Force Base	CA
Eglin Air Force Base	FL
Griffiss Air Force Base	NY
Hill Air Force Base	UT
Keesler Air Force Base	MS
K. I. Sawyer Air Force Base	MI
McChord Air Force Base	WA
McClellan Air Force Base	CA
Minot Air Force Base	ND
Patrick Air Force Base	FL
Peterson Air Force Base	CO
Tinker Air Force Base	OK
Williams Air Force Base	AZ

Primary and Tenant Airfields Used By Air Force Command

Other

Operating Bases	Primary Unit	State	Tenant Units
Arnold Air Force Station	(AFSC)	TN	
Brooks Air Force Base	(AFSC)	TX	
Chicago-O'Hare Int'l Airport	(AFR)	IL	ANG
Dobbins Air Force Base	(AFR)	GA	
Edwards Air Force Base	(AFSC)	CA	
Eglin Air Force Base	(AFSC)	FL	
General Mitchell Field	(AFR)	WI	
Greater Pittsburgh IAP	(AFR)	PA	
Hanscom Air Force Base	(AFSC)	MA	
Hill Air Force Base	(AFLC)	UT	
Kelly Air Force Base	(AFLC)	TX	AFR+ANG+ELC
Los Angeles Air Force Station	(AFSC)	CA	
McClellan Air Force Base	(AFLC)	CA	AFR
Minn-St Paul Int'l Airport	(AFR)	MN	ANG
New Orleans Naval Air Station	(AFR)	LA	ANG
Niagara Falls Int'l Airport	(AFR)	NY	ANG
Patrick Air Force Base	(AFSC)	FL	
Richards-Gebaur Air Force Base	(AFR)	MO	
Rickenbacker AGB	(ANG)	OH	AFR
Robins Air Force Base	(AFLC)	GA	
Selfridge ANGB	(ANG)	MI	AFR
Tinker Air Force Base	(AFLC)	OK	

Primary and Tenant Airfields Used By Air Force Command

Other (Continued

Operating Bases	Primary Unit	State	Tenant Units
USAF Academy	(ACD)	CO	
Westover Air Force Base	(AFR)	MA	
Willow Grove Naval Air Station	(AFR)	PA	ANG
Wright-Patterson Air Force Base	(AFLC)	OH	AFR+AFSC
Youngstown MAP	(AFR)	OH	

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GLOSSARY

A

AERA	Automated En Route Air Traffic Control
AFCC	Air Force Communications Command
AFLC	Air Force Logistics Command
AFSC	Air Force Systems Command
ANDB	Air Navigation Development Board
ASW	antisubmarine warfare
ATC	Air Training Command
ATCAA	Air Traffic Control Assigned Airspace Area
ATRB	Advanced Training Recommendation Board
AWACS	airborne warning and control system

C

CAA	Civil Aeronautics Authority
CAB	Civil Aeronautics Board
CONUS	continental United States

D

DARC	direct access radar channel
DME	distance measuring equipment
DOD	Department of Defense
DOT	Department of Transportation

E

ENJJPT	Euro-NATO Joint Jet Pilot Training
EPA	extended planning annex

F

FAA	Federal Aviation Administration
FAR	fighter/attack/reconnaissance

G

GCA	ground controlled approach
GNP	gross national product

I

ICC	Interstate Commerce Commission
IFR	Instrument flight rules
ILS	instrument landing system
IRS	Internal Revenue Service
ISJTA	intensive student jet training areas

M

MAC	Military Airlift Command
MAJCOM	major command
MLS	microwave landing system
MOA	military operations area

N

NACA	National Advisory Committee for Aeronautics
NAS	national airspace system
NATO	North Atlantic Treaty Organization
NGT	next generation trainer

P

PACAF	Pacific Air Forces
PATCO	Professional Air Traffic Controllers Organization

R

ROTC	Reserve Officers' Training Corps

S

SAC	Strategic Air Command
SOA	special operating area
SUPT	specialized undergraduate pilot training

T

TAC	Tactical Air Command
TACAN	tactical air navigation
T-CAS	threat-alert/collision-avoidance system
TTB	tanker/transport/bomber

U

UPT	undergraduate pilot training
US	United States
USAF	United States Air Force

V

VFR	visual flight rules
VOR	very high frequency omnirange
VORTAC	very high frequency omnirange/tactical air navigation

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